

E-901

THE FIRE ENDURANCE OF SPECIFIC POKE-THRU SYSTEMS MOUNTED IN CONCRETE SLABS

Technical Report No. 1

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N. E. Poulos

A. T. Sales

Prepared Under the Office of Industrial Assistance
Department of Technical Support

High Temperature Materials Division
Engineering Experiment Station
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FOREWORD

This report summarizes the work performed under a program which was conducted as a joint participation by the Engineering Experiment Station, Georgia Institute of Technology, Brooks-Allison Company and the Ira Hardin Company. Each participant contributed time and expertise to the work reported herein.

Georgia Tech was responsible for the design of the experimental apparatus, for instrumentation and compiling the thermal response data of the poke-thru systems, and for the preparation and publication of this report. Brooks-Allison was responsible for the selection and make-up of the test samples. Ira Hardin Company provided the work space, fabricated the test furnaces and concrete test slabs, and supplied all utilities needed in the performance of these tests.

All work performed by the High Temperature Materials Division was performed under the Office of Industrial Assistance, Department of Technical Support, Engineering Experiment Station, Georgia Institute of Technology, Atlanta, Georgia. The purpose of this Office is a continuing assistance by the Engineering Experiment Station to Georgia industry through technological assessment and long-range technical planning, as well as to the application of technology to help industry meet its more current problems.

Principal personnel participating in this work include N. E. Poulos, A. T. Sales and C. W. Gorton of the High Temperature Materials Division, Engineering Experiment Station, Georgia Institute of Technology; Frank Smith and Wayne Costley, Brooks-Allison Company, Atlanta, Georgia; and Earl Shell and Buddy Young, Ira Hardin Company, Atlanta, Georgia.

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I. PURPOSE

The purpose of this study is to determine the fire endurance of several specific poke-thru systems mounted in a concrete floor slab.

II. INTRODUCTION

"Poke-thru" as used here is a system used by the electrical building trade for the installation of floor-mounted convenience outlets for electric power, intercommunication systems, telephones, etc. The method of installation is essentially one with which electrical conductors are passed through a fitting inserted into a drilled hole in a floor slab and terminate at the floor outlet. The use of a poke-thru has evolved from varying requirements for convenience outlets. The flexibility in selecting the floor location and the lower cost of drilling the hole as compared to the installation cost of conventional convenience outlets has increased the use of the poke-thru in new building construction. This increased use has drawn the attention of fire, electrical, and building departments of some municipal, county and state governments, architects and builders as to the fire endurance and the fire propagation potential of the poke-thru. The interest has been intensified recently by several severe fires in high-rise structures. Some of these fires were on floors which were above the fire fighting height capability of the rolling fire fighting equipment.

Two Atlanta based firms, Ira Hardin Company, General Contractors, and Brooks-Allison, Electrical Contractors, requested assistance from the High Temperature Materials Division, Engineering Experiment Station, Georgia Institute of Technology in determining the fire endurance of several specific poke-thru systems. The High Temperature Materials Division was to provide technical assistance, the instrumentation, and was responsible for the recording and the reporting of the fire endurance data, Brooks-Allison Company was to make-up the specific poke-thru samples, and the Ira Hardin

Company was to construct and house the fire test furnace and supply all utilities. The results of this cooperative effort are reported herein.

III. THERMAL EVALUATION STUDIES

A. Fire Test Furnace

Two furnaces were used for these studies and were constructed following the sketch shown in Figure 1. The fire chamber is made up of K-30 (3000° F maximum use temperature) refractory bricks laid without mortar to form walls of about 5 inches in thickness and about 49 inches in height. This furnace size is similar to the size used by Abrams and Gustaferro for their studies on the fire endurance of concrete slabs 1/. The bricks are laid following the pattern shown in Figure 3. This pattern is used to block direct thermal radiation from the fire chamber through the unmortared brick joints. The walls are supported by a 4 foot x 4 foot x 3-1/2-inch cast concrete base having six drilled burner ports to accommodate North American Type 102 Burners. The burner ports are drilled following the pattern shown in Figure 2 to prevent the direct alignment of the axis of the poke-thru fittings with the burner ports.

The furnace is fired with LP gas and compressed air. Furnace temperature is manually controlled and is monitored by two thermocouples mounted in capped black iron pipes as shown in Figure 1. Control of the furnace temperature is accomplished by regulating manually the fuel and air flow control valves and damping the flow of the exhaust gases thru the fire chamber vents by the placement of refractory bricks in the vent openings.

B. Cast Concrete Fire Test Slabs

All of the test slabs used in these studies were 3 feet x 3 feet x 3-1/2 inches and were reinforced with 1/2-inch steel rods and cast using the concrete mixture listed in Table I. Four poke-thru holes were drilled following the

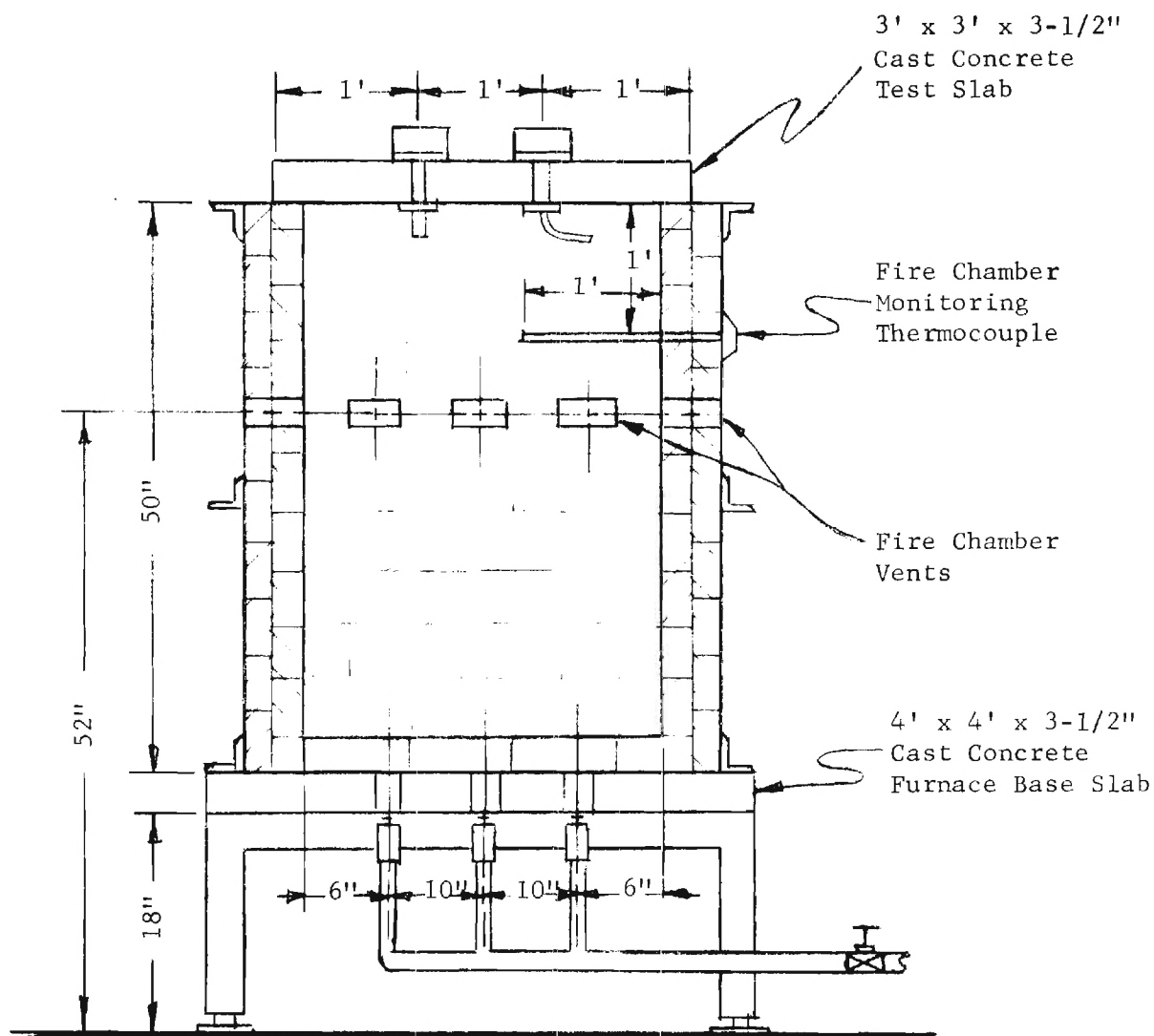


Figure 1. Test Furnace for Fire Endurance Evaluation of Poke-Thru Systems.

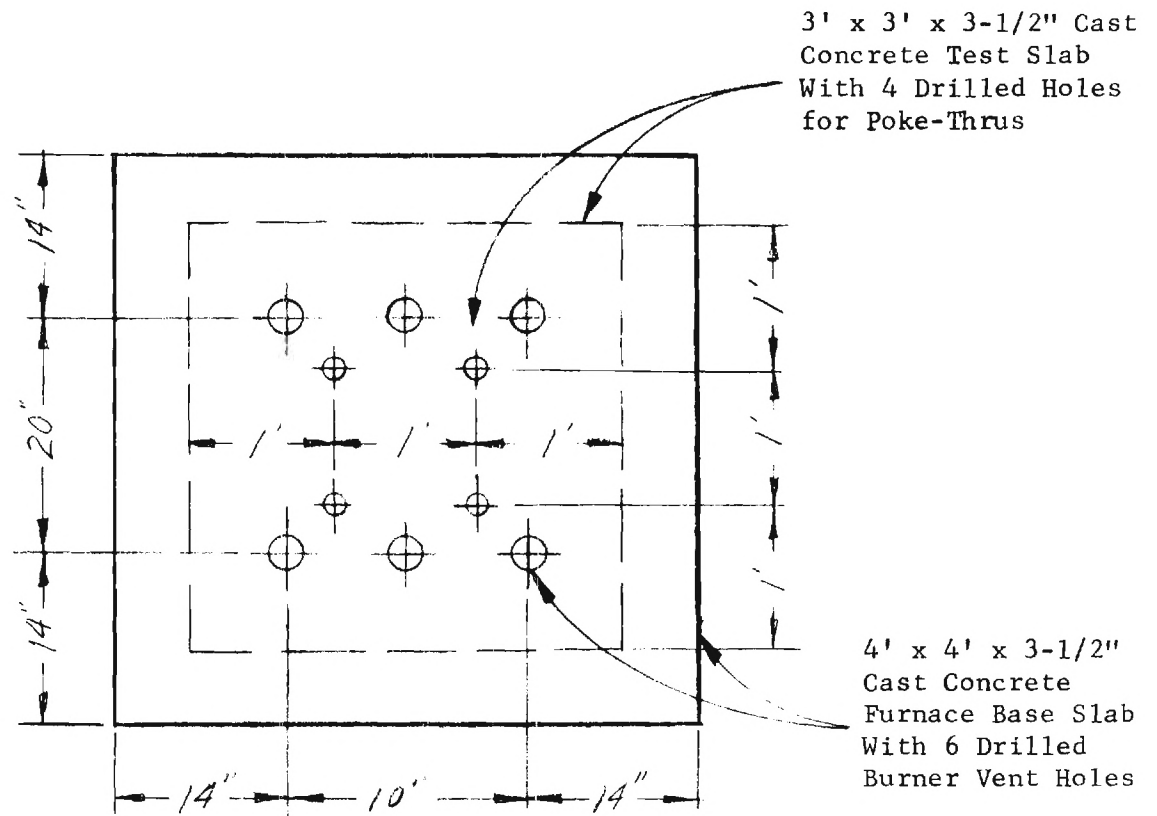


Figure 2. Drilled Hole Patterns for Test Slab and Furnace Base Slab.

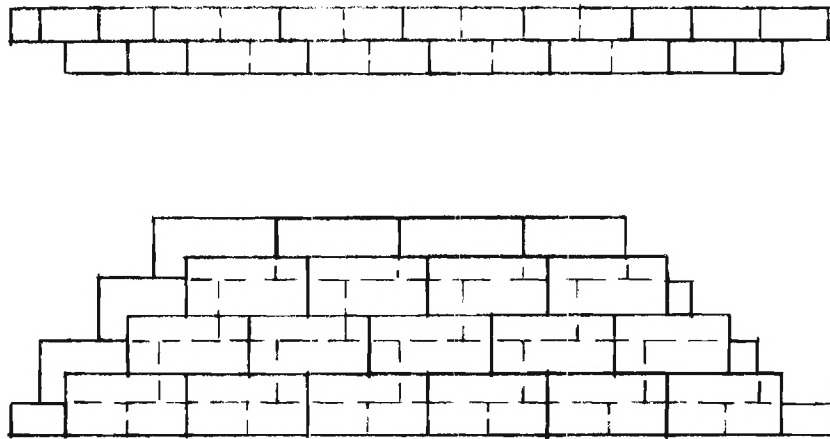


Figure 3. Pattern for Laying Furnace Refractory Brick.

TABLE I
REPRESENTATIVE CONCRETE MIX OF THE TEST SLABS

<u>Item</u>	<u>Remarks</u>	<u>Materials Per Cubic Yard (Saturated, Surface Dry)</u>
Cement	Lone Star	705 lbs.
Fine Aggregate	South Georgia Sand	1272 lbs.
Coarse Aggregate	Vulcan Lightweight	665 lbs.
Water	---	45 lbs.
Admixture	Pozolith 100N & MBVR	3 ozs. per 100 lbs. cement & MBVR as required to produce 4 to 6 percent air

<u>Item</u>	<u>Test Data</u>
Water-Cement Ratio Gallons Per Sack	6.0
Actual Slump Inches	5
Air Content, Percent by Volume	5.5
Average Compressive Strength at 7 Days PSI	4,630
Average Compressive Strength at 28 Days PSI	5,290

<u>Item</u>	<u>Fine Aggregate</u>	<u>Coarse Aggregate</u>
Fineness Modulus	2.11	6.22
Size	No. 8	1/2-inch
Specific Gravity (S.S. Dry)	2.62	---

Note: The above values are not a verified analysis for any specific test slab.

pattern shown in Figure 2. In practice, break-outs of the cast concrete may occur at the drilled hole site during the drilling operation. Therefore, no attempt was made to prevent or minimize the occurrence of break outs nor to patch them. The holes were drilled as shown in Figure 5. The hole was

usually drilled to a size which would result in a tight fit with the conduit of the poke-thru fitting or with a conductor. However, some of the fittings made up with 1/2-inch and 3/4-inch conduits were installed in oversize 1-1/8-inch diameter holes. This size hole was selected to simulate conventional installation of service outlets.

C. Description of Poke-Thru Fittings Evaluated

Figure 4 is a sketch of a typical poke-thru fitting for a telephone outlet. This type fitting is essentially the same as is used for other services such as electrical and intercommunication systems.

Table II lists nine poke-thru systems evaluated in this study. All conduits for the 110 volt devices also included the conductors. The conduits were sealed below the slab by pinching the open end. This was an attempt to simulate a closed system of conduits to junction boxes.

Conduits for telephone outlets were evaluated with straight nipples and elbows below the slab.

D. Instrumentation and Temperature Measuring System

The temperature of the poke-thru assembly above the concrete slab was monitored using two 20-gage chromel-alumel (Type K) thermocouples. One thermocouple was mounted under the outlet assembly. It was positioned so that it would be in direct contact with the top of the concrete slab and with the bottom side of the plate shown in Figure 4. The second thermocouple was placed under a screw head on the cap. Kaowool^{(R)*} was placed over the thermocouples to stabilize assembly monitor temperatures by shielding the effects of ambient temperatures and transient wind conditions. See Figure 6.

*A ceramic fiber insulative batting which can be used in heats to 2300° F.

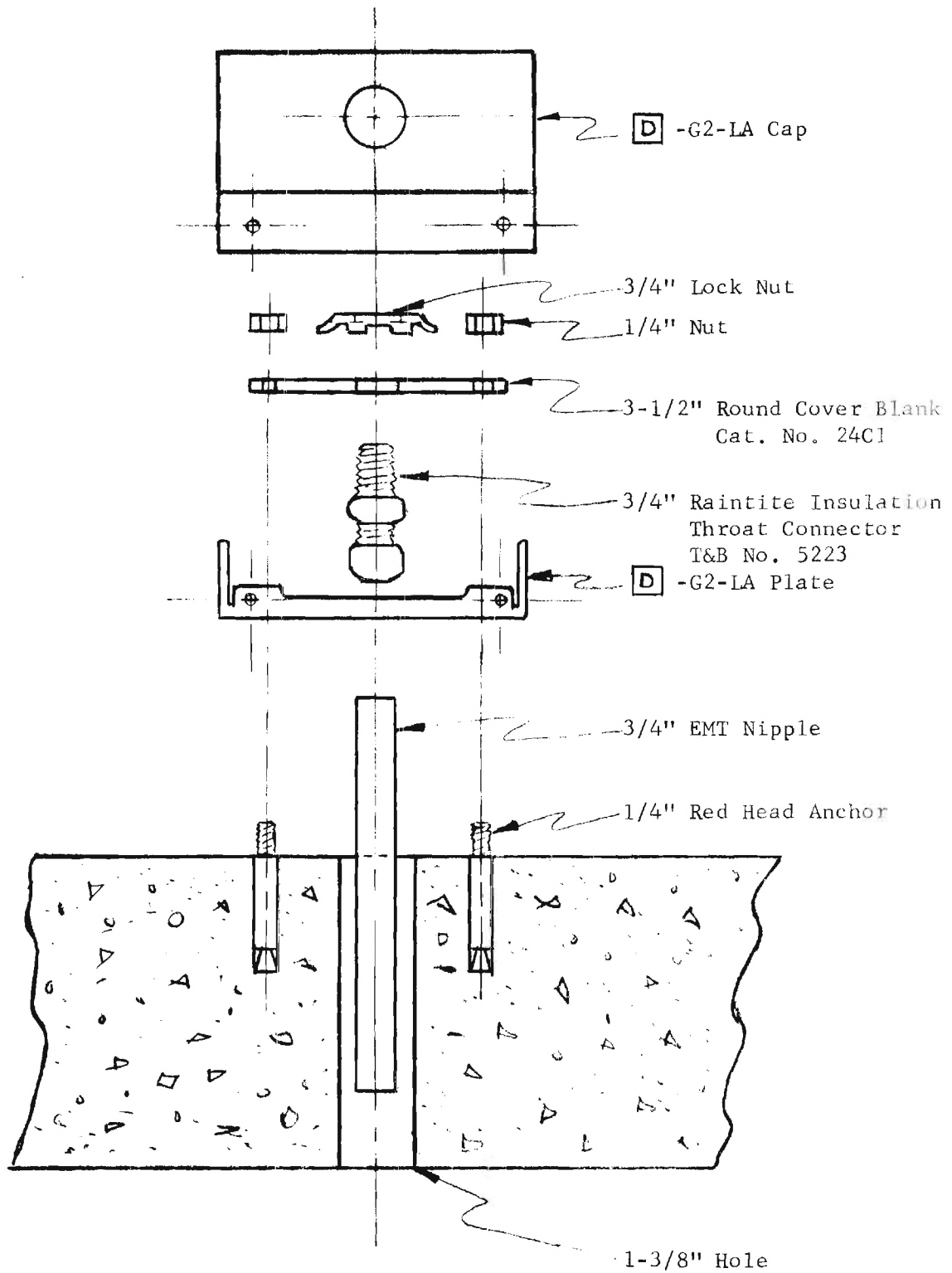


Figure 4. Telephone Service Fitting (Typical).

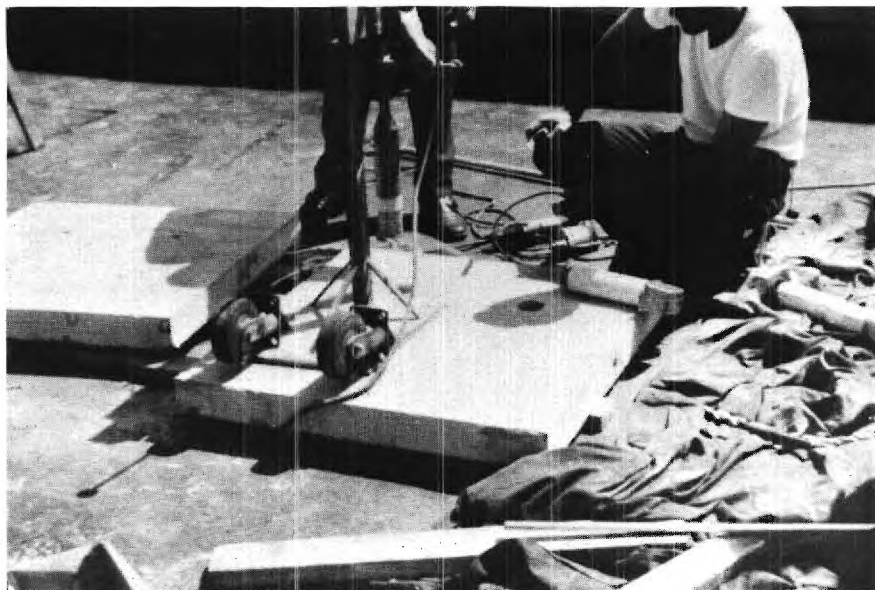


Figure 5. Drilling Holes in Test Slab for Mounting Poke-Thru Fittings.

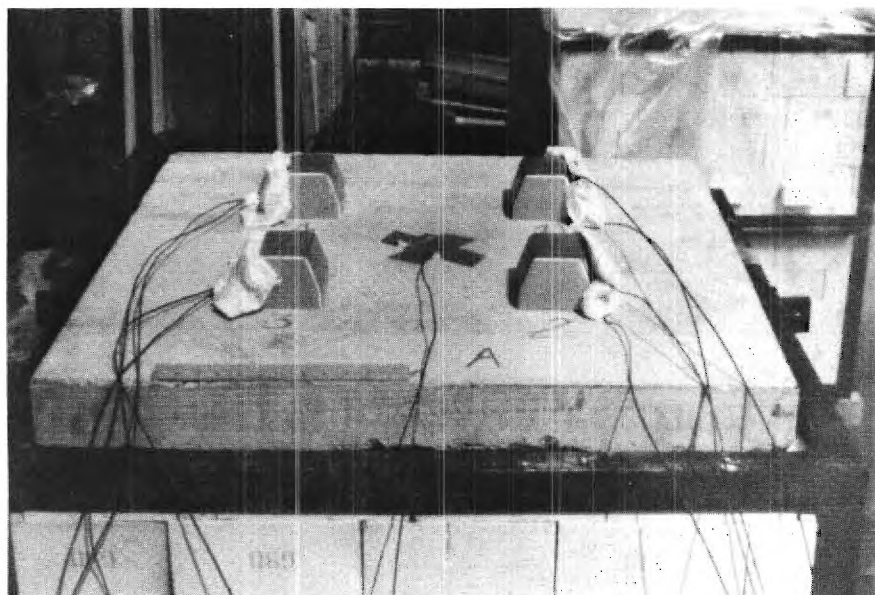


Figure 6. Instrumented Convenience Outlets, Test Slab, and Test Furnace.

TABLE II
POKE-THRU SYSTEMS FIRE TESTED

Poke-Thru System	Type Outlet	Fitting Thru Hole in Concrete	Diam. of Hole in Concrete	Poke-Thru Tested	
				No.	Materials Added to or Variations in the Poke-Thru Fitting
I	110 volt	1/2" EMT	1-1/8"	1.	none
				4.	grouted around conduit
				15.	asbestos plaster mix around conduit
				17.	carpet & pad No. 1 (rerun of test No. 1)
				31.	asbestos plaster mix around conduit (rerun of test No. 15)
II	110 volt	1/2" EMT	tight	2.	none
				3.	grouted around conduit
				6.	grouted around conduit and chico inside conduit
				14.	Kaowool ^(R) around conduit
				18.	carpet & pad No. 1 (rerun of test No. 2)
				21.	none (rerun of test No. 2)
				24.	Kaowool ^(R) around conduit (rerun of test No. 14)
				25.	carpet & pad No. 3 (rerun of test No. 2)
				28.	Kaowool ^(R) around conduit-carpet & pad No. 2 (rerun of test No. 14)

(Continued)

TABLE II (Continued)
POKE-THRU SYSTEMS FIRE TESTED

Poke-Thru System	Type Outlet	Fitting Thru Hole in Concrete	Diam. of Hole in Concrete	Poke-Thru Tested	
				No.	Materials Added to or Variations in the Poke-Thru Fitting
III	Telephone	3/4" EMT	1-1/8"	16.	asbestos plaster mix around conduit
				29.	asbestos plaster mix around conduit (rerun of test No. 16)
IV	Telephone	3/4" EMT	tight	10.	grouted around conduit, straight nipple
				11.	grouted around conduit, elbow below floor
				12.	Kaowool ^(R) around conduit, straight nipple
				19.	carpet & pad No. 1
				23.	straight nipple
				30.	elbow-short (6") & held close to slab
V	110 volt	BX Cable	tight	32.	straight nipple - short
				27.	straight nipple - short carpet & pad No. 3 (rerun of test No. 23)
				5.	grouted around cable
				20.	carpet & pad No. 1 (rerun of test No. 5)

(Continued)

TABLE II (Concluded)
POKE-THRU SYSTEMS FIRE TESTED

Poke-Thru System	Type Outlet	Fitting Thru Hole in Concrete	Diam. of Hole in Concrete	Poke-Thru Tested	
				No.	Materials Added to or Variations in the Poke-Thru Fitting
VI	Telephone	none	tight	9.	cable only
				22.	cable only (rerun of test No. 9)
				26.	cable only - carpet & pad No. 3 (rerun of test No. 9)
VII	110 volt	2" Transite	tight	7.	Transite filled with chico
XIII	Telephone	2" Transite	tight	8.	Transite filled with chico
IX	110 volt	1/2" RIC Conduit	tight	13.	cable only

NOTE 1:

Grouted - sand & portland cement

Chico - a plaster sealing compound used to seal explosion proof electrical fittings - underwriters approved material

EMT - electrical metallic tubing

BX Cable - metal clad cable

Kaowool[®] - A ceramic fiber insulative batting which can be used in heats to 2300° F.

Carpet & Pad No. 1 - Class "C" rating with reconstructed vinyl pad

Carpet & Pad No. 2 - Class "B" rating with rubber-coated hair and fiber pad

Carpet & Pad No. 3 - Shag carpet, self-extinguishing, with rubber-coated hair and fiber pad

R.I.C. - rigid iron conduit

NOTE 2: All Devices and Installation Similar to Dwg. No. SK-ANI-TF-1.

NOTE 3: Tight under diameter of hole in concrete heading is that diameter which makes for a snug fit with the conduit/conductor.

The temperature of the top of the concrete slab was measured using a 20-gage K-thermocouple positioned in the center area of the slab. Kaowool[®] was also used on this thermocouple. However, a load was placed on the Kaowool[®] to hold the thermocouple in contact with the slab. See Figure 6.

Calibrated extension wire for K-thermocouples were attached to each respective lead with split-bolt, copper connectors. The other end of each lead was wired to a 12-point strip-chart recorder. The recording unit was calibrated for measurement of a ten-millivolt maximum span and recorded the emf outputs of the eight poke-thru thermocouples and one concrete slab thermocouple. The ten-millivolt span was equivalent to a temperature of 475° F which is adequate to measure the testing temperature termination of 325° F above ambient.

Two ceramic insulated, 14-gage chromel-alumel thermocouples were mounted in 1/2-inch black iron pipe which had been welded closed at one end. These two units were each mounted horizontally 12 inches below the bottom of the concrete slab. The units were positioned in the diagonally opposite corners with the tips of each thermocouple pointed to the opposite wall of the furnace cavity and 12 inches from the adjacent walls. See Figure 1.

Each thermocouple was connected with calibrated extension wire to a multipoint strip-chart recorder which had been calibrated for a fifty-millivolt maximum span. The span is equivalent to a temperature of 2247° F, this is more than adequate for the tests since the maximum furnace temperature would be 2000° F.

A micro-optical pyrometer was used to check the furnace temperatures by sighting on the hot, closed end of the thermocouple well. The flames in the

furnace created color matching disturbances which made accurate optical temperature measurements essentially impossible.

Before and after thermal evaluation, color slides were photographed as visual records for each poke-thru. The photographs were of the top and bottom of the concrete test slab with each poke-thru mounted.

E. Fire Test Procedure

A 3 foot x 3 foot x 3-1/2-inch concrete test slab, without mounted poke-thru devices, was lifted into position on the furnace by means of a fork truck. A thermocouple was mounted on the top center of the slab. This set up was for a furnace heating calibration run. The furnace atmosphere temperature of these tests approximate the recommended temperature/time profile for the fire endurance evaluation of concrete floor slabs (without poke thrus).

With a portable air compressor running and the delivery valve open, air was delivered to the closed furnace cut-off valve. The LP gas valve was opened for gas delivery to the closed furnace cut-off valve. With the two cut-off valves partially opened, an attempt was made to ignite the burners by means of a small, portable propane torch but the volume of air was too large. Manipulation of the air cut-off valve did not alleviate this difficulty. The air valve was then opened and the volume of air metered by the delivery valve, a ball type, mounted on the air compressor.

With the furnace gas valve opened approximately one-quarter turn and the air delivery valve partially opened, the burners were individually ignited; and, simultaneously, the multipoint and 12-point recorders were turned on. All furnace vents were open.

A slightly reducing flame with a height that reached to the furnace vents was found to produce the rapid heating schedule needed for the first 10 minutes. The air delivery valve was then further opened until an oxidizing furnace atmosphere was observed, and the furnace gas valve was adjusted to follow the required heating schedule.

Since this procedure for maintaining furnace atmosphere was not difficult, it was used in all the succeeding poke-thru fire tests.

IV. RESULTS AND DISCUSSION

A. Introduction

Before presenting the results obtained in this program aspects of the tests and test conditions should be discussed.

As far as can be determined, no standard test exists for determining the fire endurance of poke-thru devices. Another facility 1/ was located which had evaluated such poke-thru devices and used a modified test procedure of an ASTM test which was established for the evaluation of concrete slabs. Their tests were related indirectly to the test conditions required by the EES. It should be emphasized that the test procedure of both facilities designated as ASTM Standards Designation E119-71, is not a standard for poke-thru devices. However, it was felt that the type of thermal environment designated by this test probably represented the state of technology for such tests and was selected for the tests reported here.

Because of the space and time limitations, the test furnaces used in this program were set up outdoors. No provisions were made for protecting the cool (top) side of the slab containing the poke-thru devices from the prevailing atmospheric conditions of sunshine and wind. Therefore, there were certain variables that could not be controlled from test to test. Although these variables were not desirable and could affect the quantitative value of the test results, it was felt that the overall qualitative value of these tests was significant.

B. Results

Fire endurance evaluations were made on thirty-two poke-thru assemblies which were classified under nine poke-thru systems catagorized by type of

outlet, diameter of hole in the concrete slab, and fitting through the hole. These evaluations were made using 3 foot x 3 foot x 3-1/2-inch concrete slabs as sample holders for four poke-thru assemblies.

Although four test furnaces were constructed and available for use, only two furnaces were used during the evaluations and only one at a time. Test set-up time, manual control of the furnace atmosphere, and test instrumentation dictated the use of only one furnace. The second was put to use when it was possible to make two test runs in one day; that is, the first furnace cooled while the second was used.

Since these furnaces were scheduled to be used only for this program, they were considered to be a temporary facility. Therefore, the furnaces were set up for manual furnace atmosphere control; they were located outdoors since suitable indoor space was not available. Although the furnace temperature was controlled manually, a close approximation to a recommended furnace atmosphere profile was obtained 2/. Figure 7 is a comparison of this recommended time/temperature profile which was typical for the evaluations reported herein (white and black dots).

The variation in the eight time/temperature heating profiles, as measured on the top surface of each concrete slab at the center and shown in Figure 8 make direct comparisons of poke-thru systems very difficult. The ambient temperature of 75° F measured where the test instruments were located did not reflect the effect of solar radiation or variation in wind currents on the top surface temperature of the slab.

Although attempts were made to protect the furnaces and test slabs from moisture pickup, it was not possible to anticipate all weather changes. At the end of a day's testing, the furnaces were still very hot and were allowed

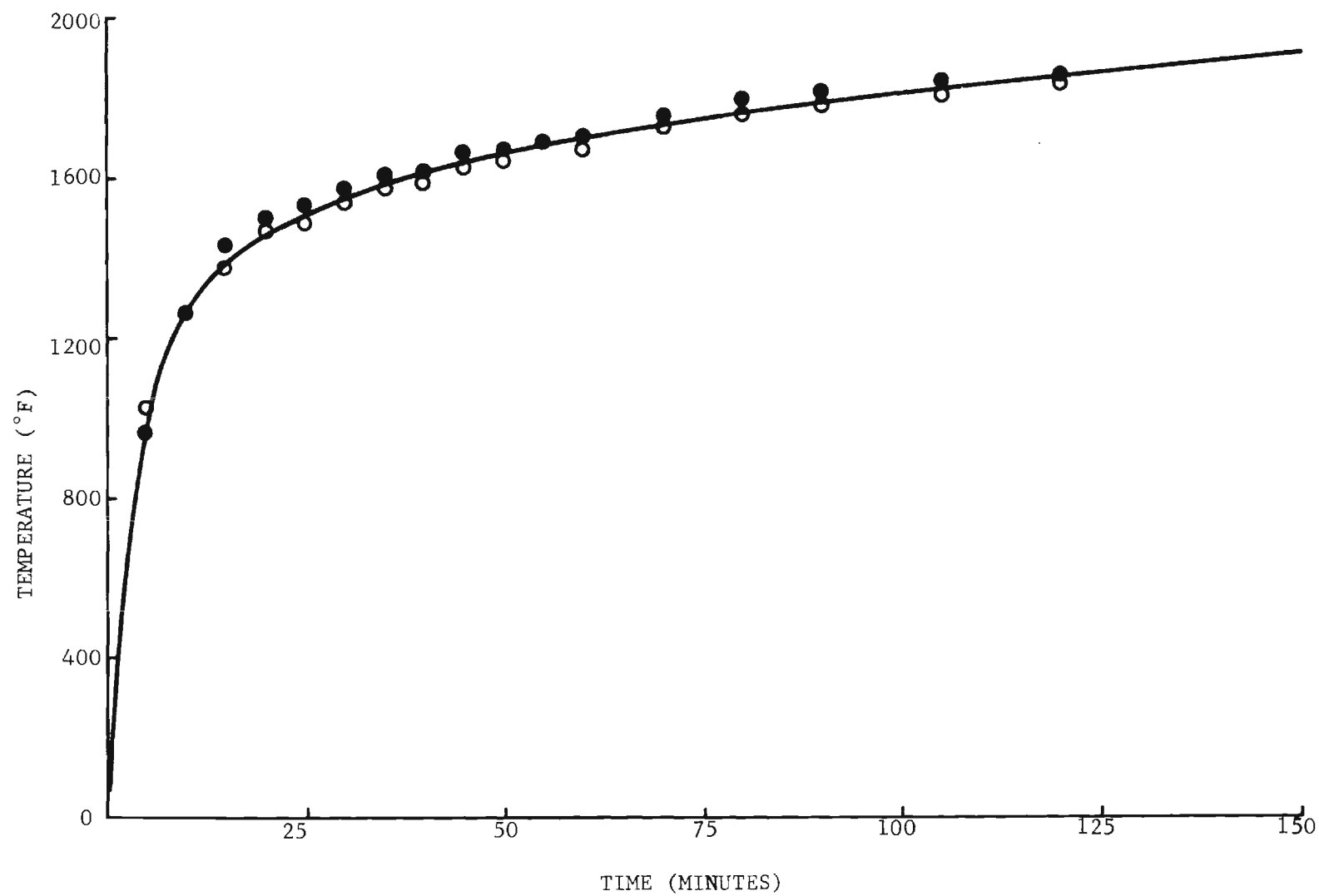


Figure 7. Typical Time/Temperature Profile of Furnace Atmosphere for Poke-Thru Fire Tests.

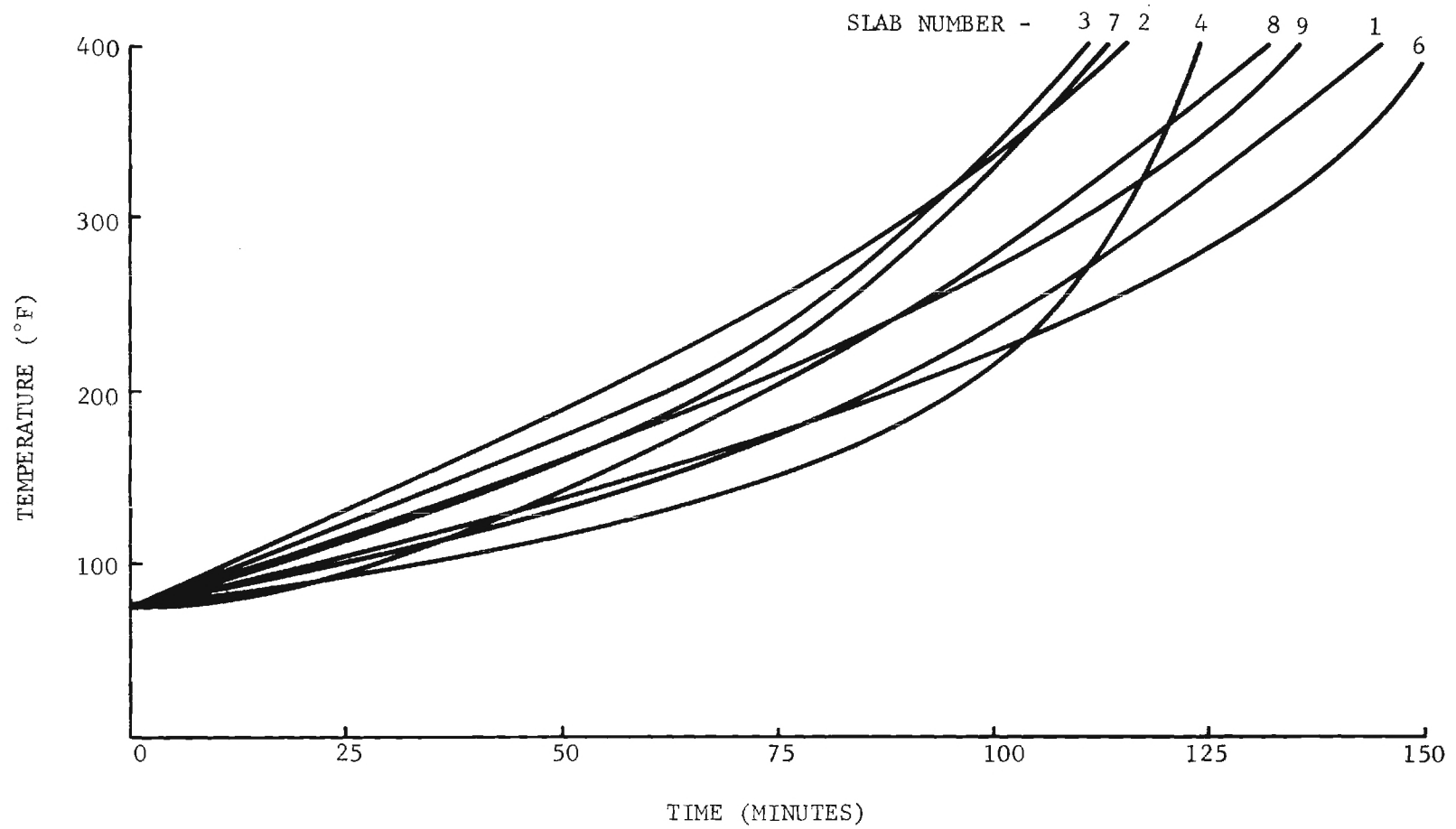


Figure 8. Variation in Time/Temperature Heating Profiles Measured at the Top of the Eight Test Concrete Slabs.

to cool uncovered overnight. Rain occurred on several different nights and days and could have increased the moisture content of both the furnaces and concrete slabs. Even though the desired furnace atmosphere time/temperature heating profile was maintained, these moisture effects could have been one of the factors which produced the variation in heating rates of the slabs.

The time/temperature profiles for the poke-thru systems listed in Table II are shown in the Appendix. The temperature measurements were taken at two locations on each system; these measurements accounted for the two heating curves obtained. The profile for the top center of each concrete slab surface on which the systems were mounted is also shown. Evaluation of the fire endurance of each poke-thru system should be determined in comparison to the individual concrete slab on which it was mounted.

The fire endurance evaluation of poke-thrus mounted over carpet gave data which was particularly difficult to analyze. It was decided that the evaluation of this type of system (concrete slab, poke-thru, electrical connections, carpet and carpet pad) could not be directly related to the individual components and their respective fire endurance. Also, the carpet and carpet pad size as used and the method of test instrumentation might not be the optimal test procedure to be used for such an evaluation. Carpet and carpet pad flamability test procedures have been established by federal law 3/. Therefore, just as the use of poke-thrus have been questioned because their use might change the fire rating of the concrete floor, it might be possible to extend such inquiries to the effect poke-thrus might have on the fire-rating of carpets and pads. Therefore, the results of these tests require special, careful scrutiny.

Several poke-thru systems require additional evaluation under more closely controlled test conditions. Interesting results were obtained for the asbestos/plaster coated conduit in systems I and III, as can be seen in their respective heating rates in Figures 15 and 16. It was assumed that the asbestos/plaster coating over the conduit produced a cooling effect over an extended period of time. Exactly what was responsible for the observed effect, and just how a period of use prior to a fire would influence this effect could be valuable information for the design of fire-resistive, poke-thru systems.

The results obtained in system VI (no electrical fittings, such as EMT, BX, transite nipples, etc., through the concrete) suggests additional testing. For example, fire endurance of wires of different sizes and with various insulative sheathing fitted through holes in the concrete slab would be of interest for their use in poke-thru systems. These wires could possibly act like a plug to halt the propagation of flame through the hole and retain the fire rating of the concrete.

The difference in the elapsed time, approximately one-half hour, for the surfaces of the eight concrete slabs to reach a temperature of 325° F above ambient, make direct comparisons of poke-thru assemblies mounted on these slabs difficult. It might be possible for the fire endurance of an assembly on one of the slabs which required a long interval to reach heat to behave differently when the elapsed time is of a shorter duration. Therefore, the results should be evaluated for their qualitative merit in the individual test.

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APPENDIX

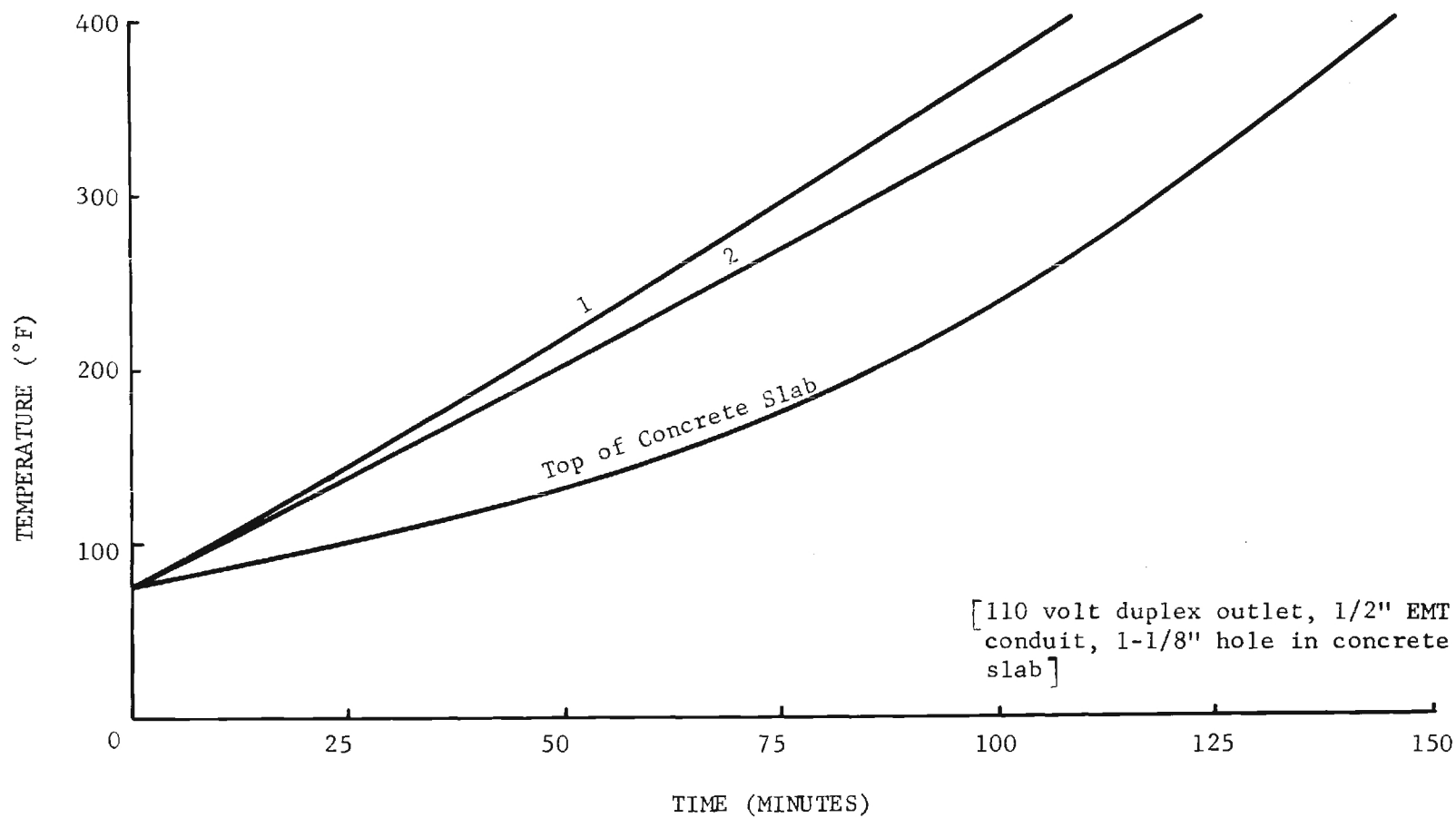


Figure 9. Temperature versus Time for Fire Test of Poke-Thru System Number 1 with Temperature Measurement at Bottom (Number 1) and Top (Number 2) of Poke-Thru Cover.

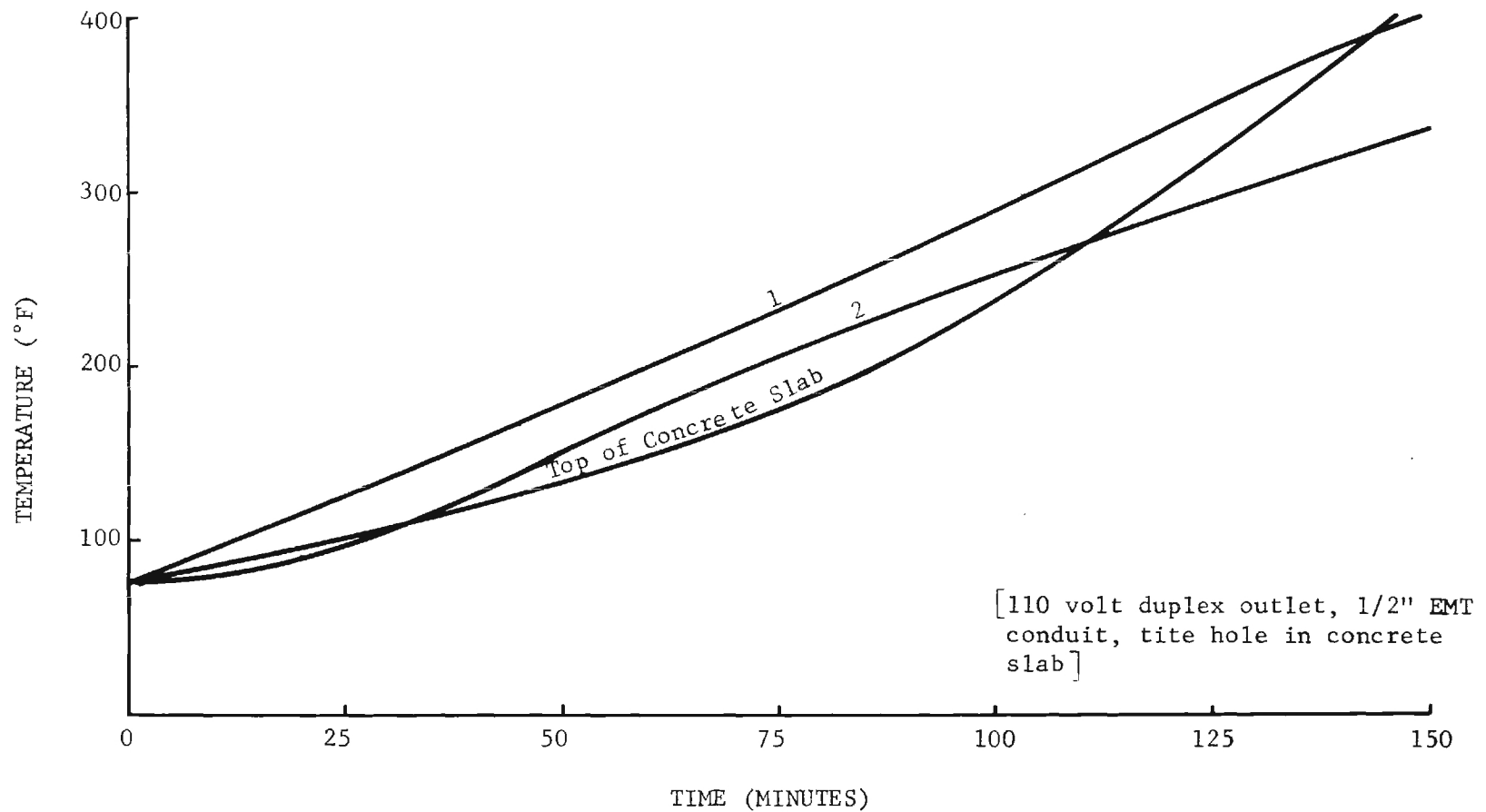


Figure 10. Temperature versus Time for Fire Test of Poke-Thru System Number 2 with Temperature Measurement at Bottom (Number 1) and Top (Number 2) of Poke-Thru Cover.

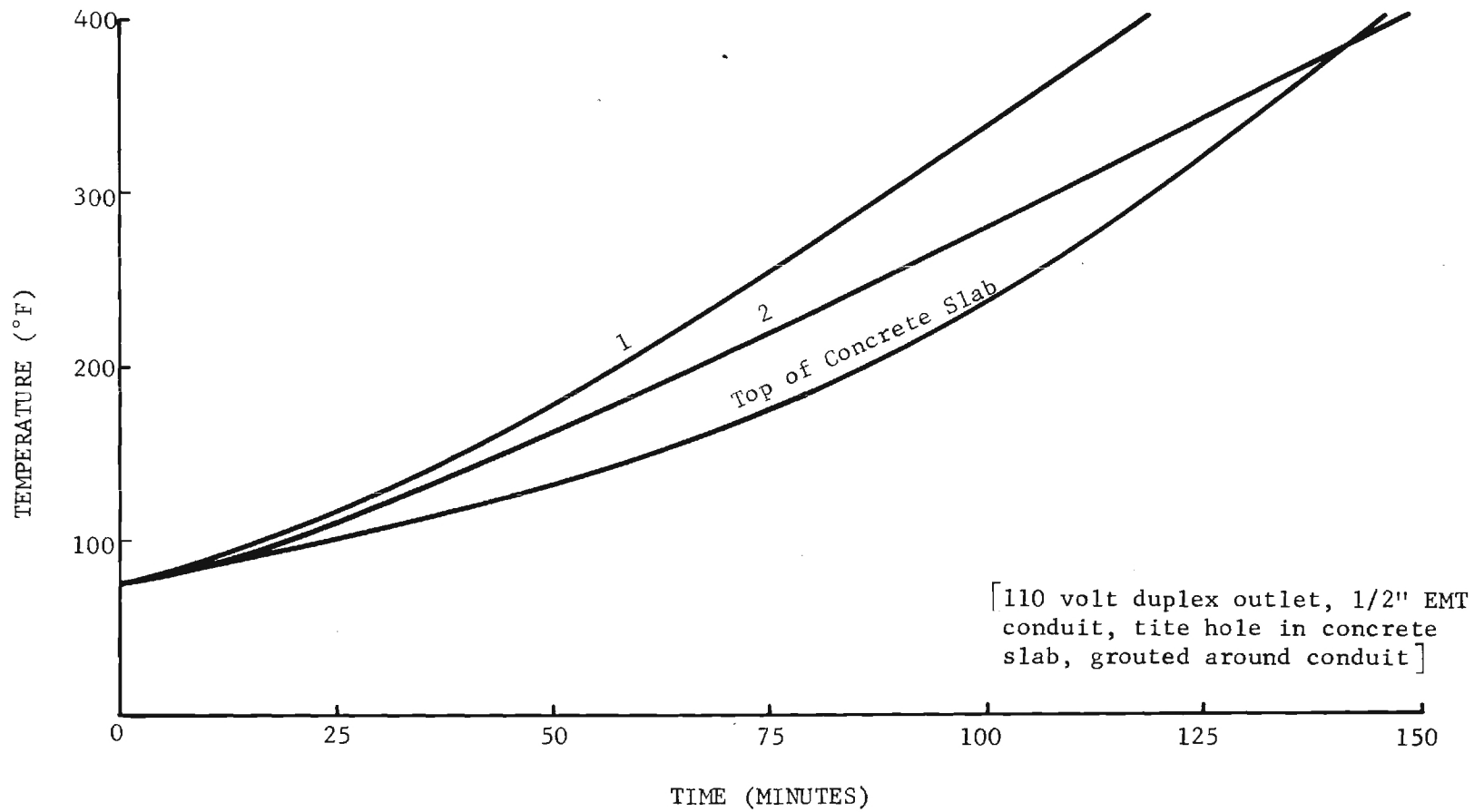


Figure 11. Temperature versus Time for Fire Test of Poke-Thru System Number 3 with Temperature Measurement at Bottom (Number 1) and Top (Number 2) of Poke-Thru Cover.

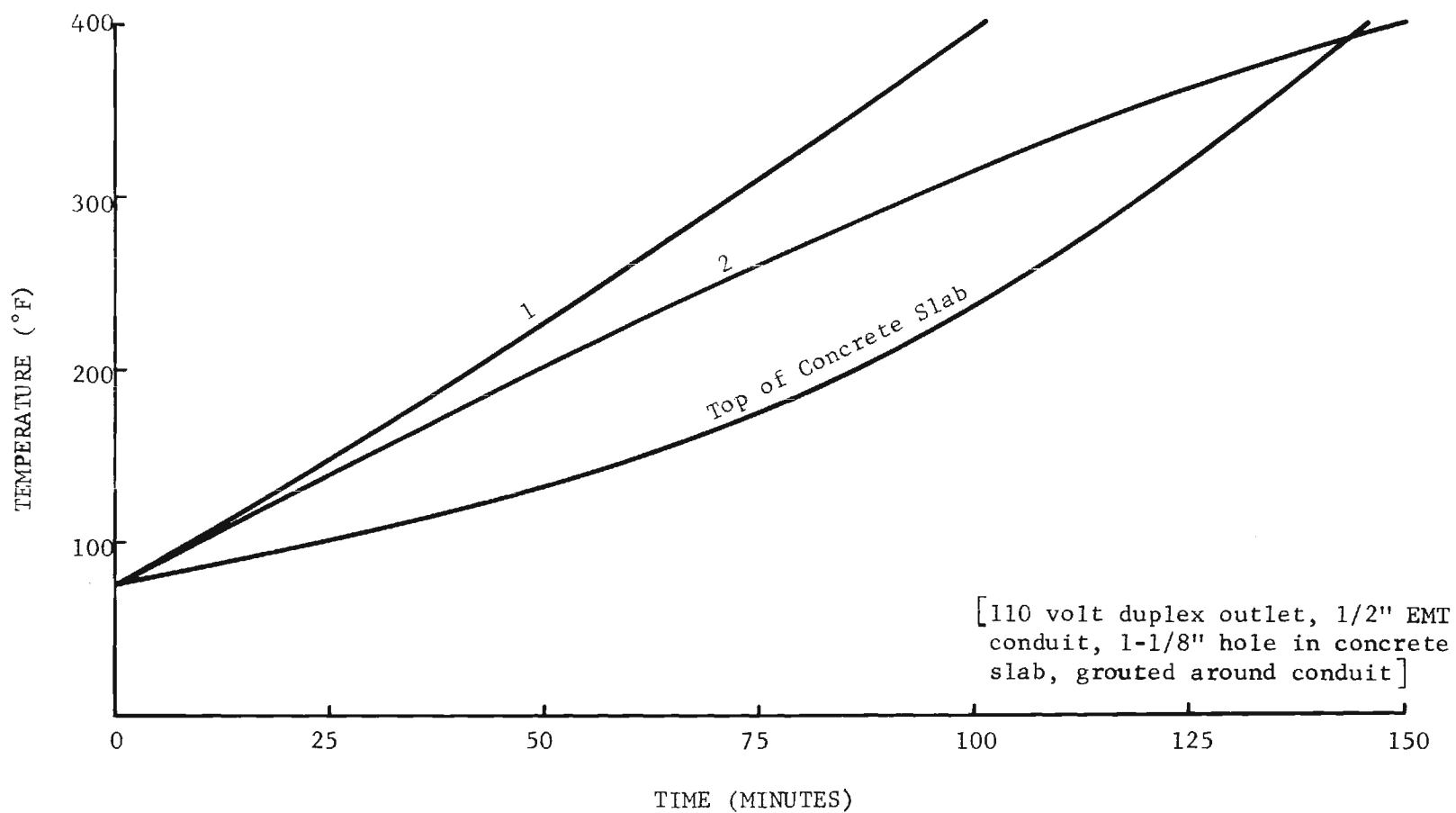


Figure 12. Temperature versus Time for Fire Test of Poke-Thru System Number 4 with Temperature Measurement at Bottom (Number 1) and Top (Number 2) of Poke-Thru Cover.

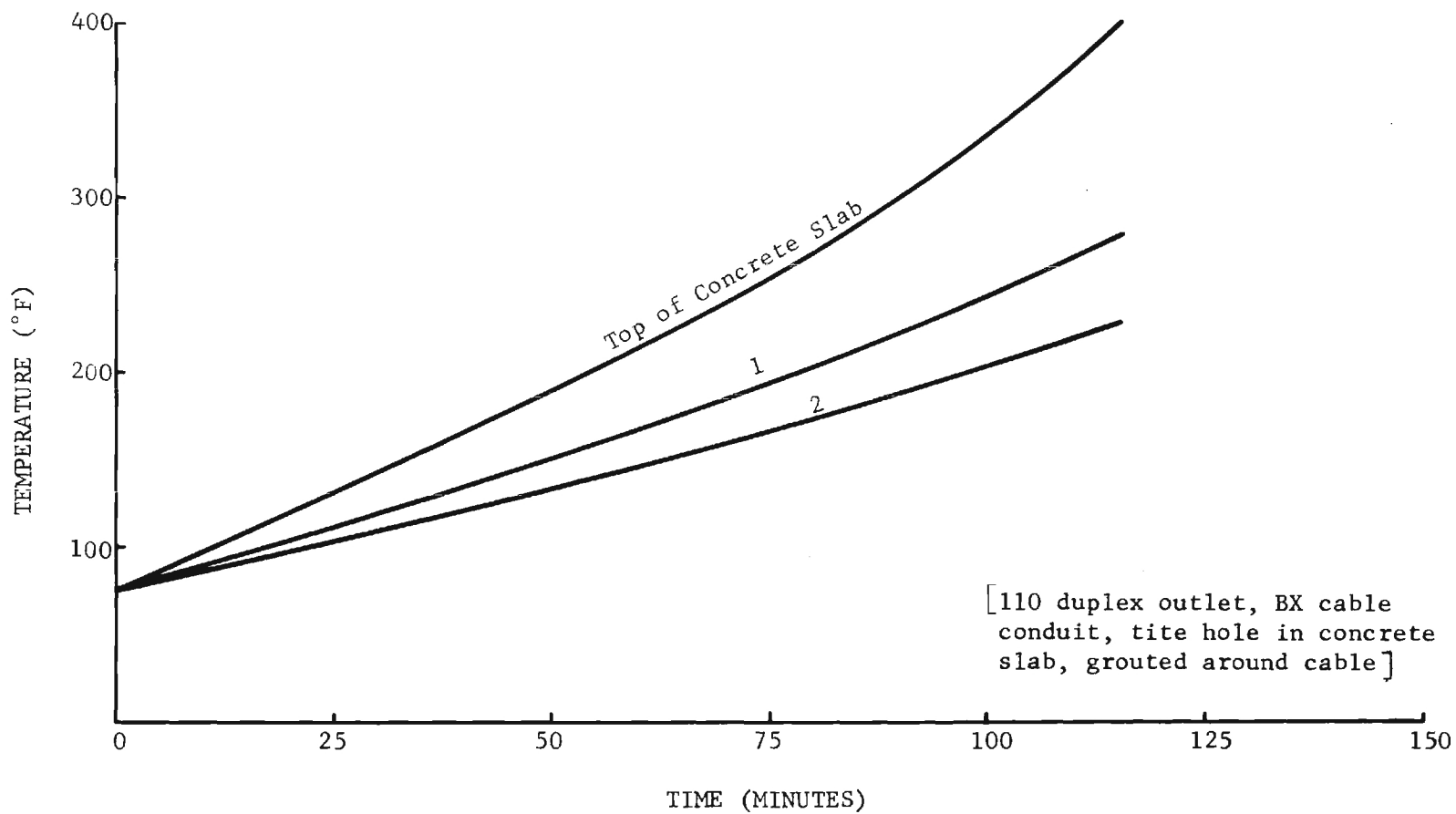


Figure 13. Temperature versus Time for Fire Test of Poke-Thru System Number 5 with Temperature Measurement at Bottom (Number 1) and Top (Number 2) of Poke-Thru Cover.

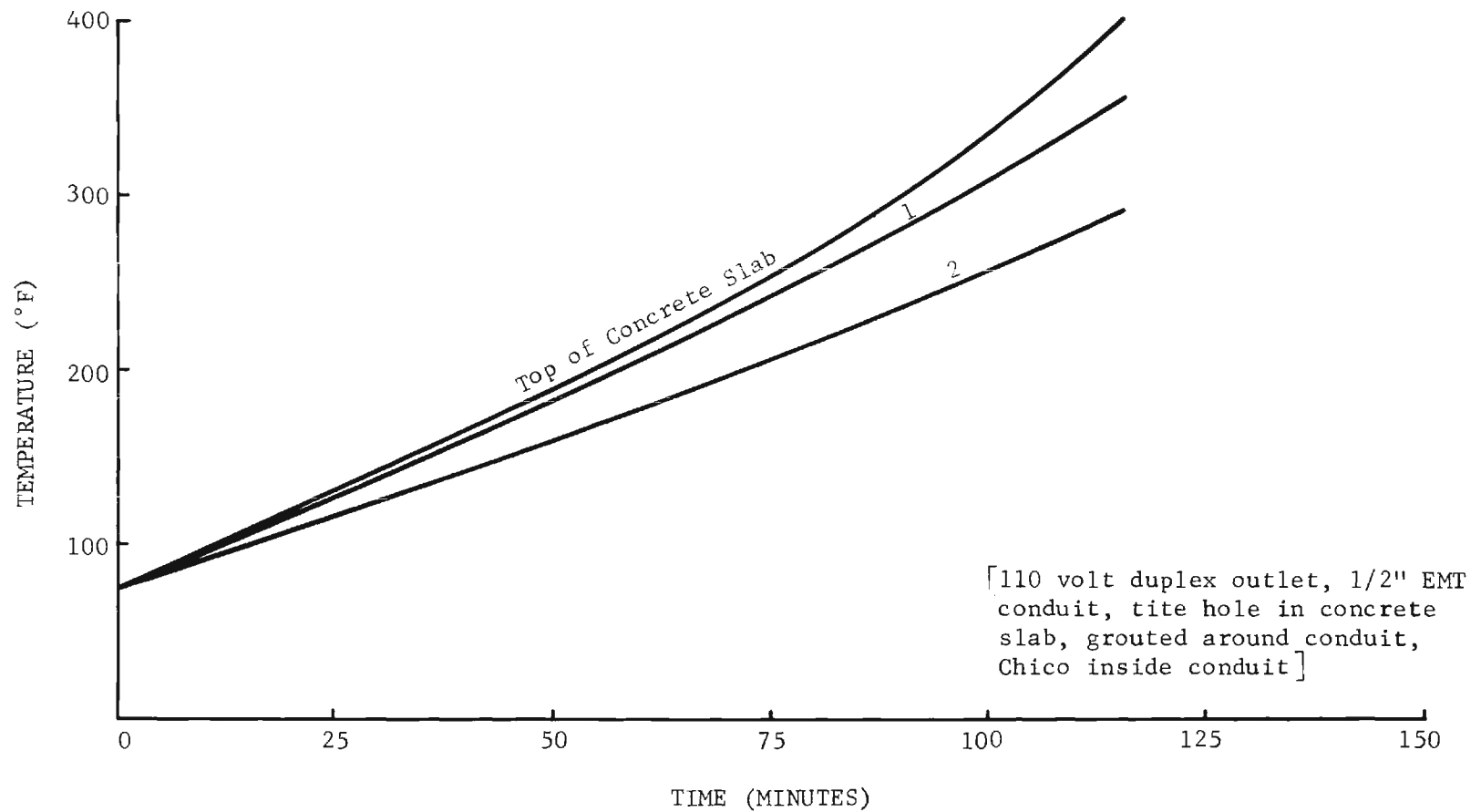


Figure 14. Temperature versus Time for Fire Test of Poke-Thru System Number 6 with Temperature Measurement at Bottom (Number 1) and Top (Number 2) of Poke-Thru Cover.

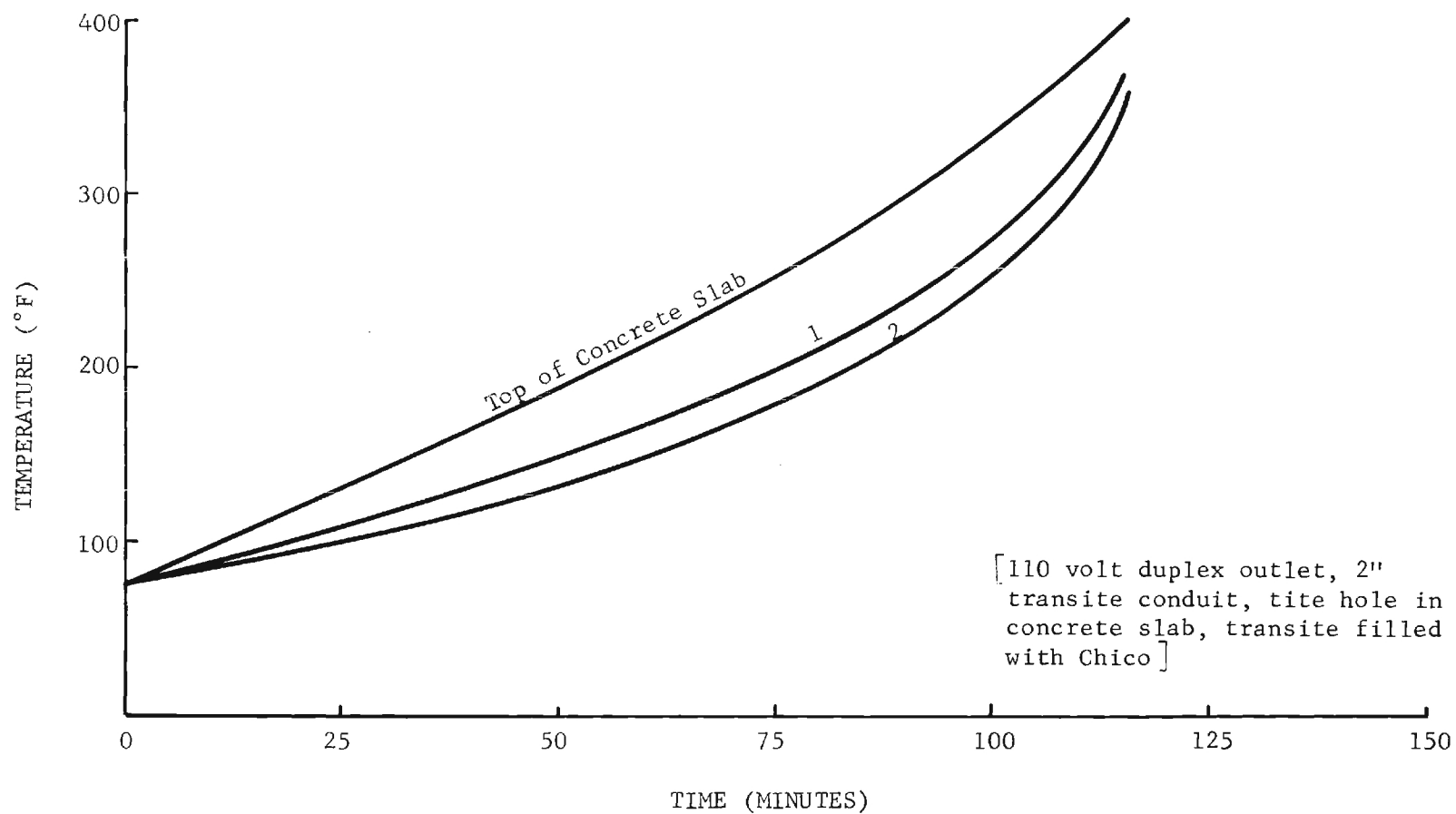


Figure 15. Temperature versus Time for Fire Test of Poke-Thru System Number 7 with Temperature Measurement at Bottom (Number 1) and Top (Number 2) of Poke-Thru Cover.

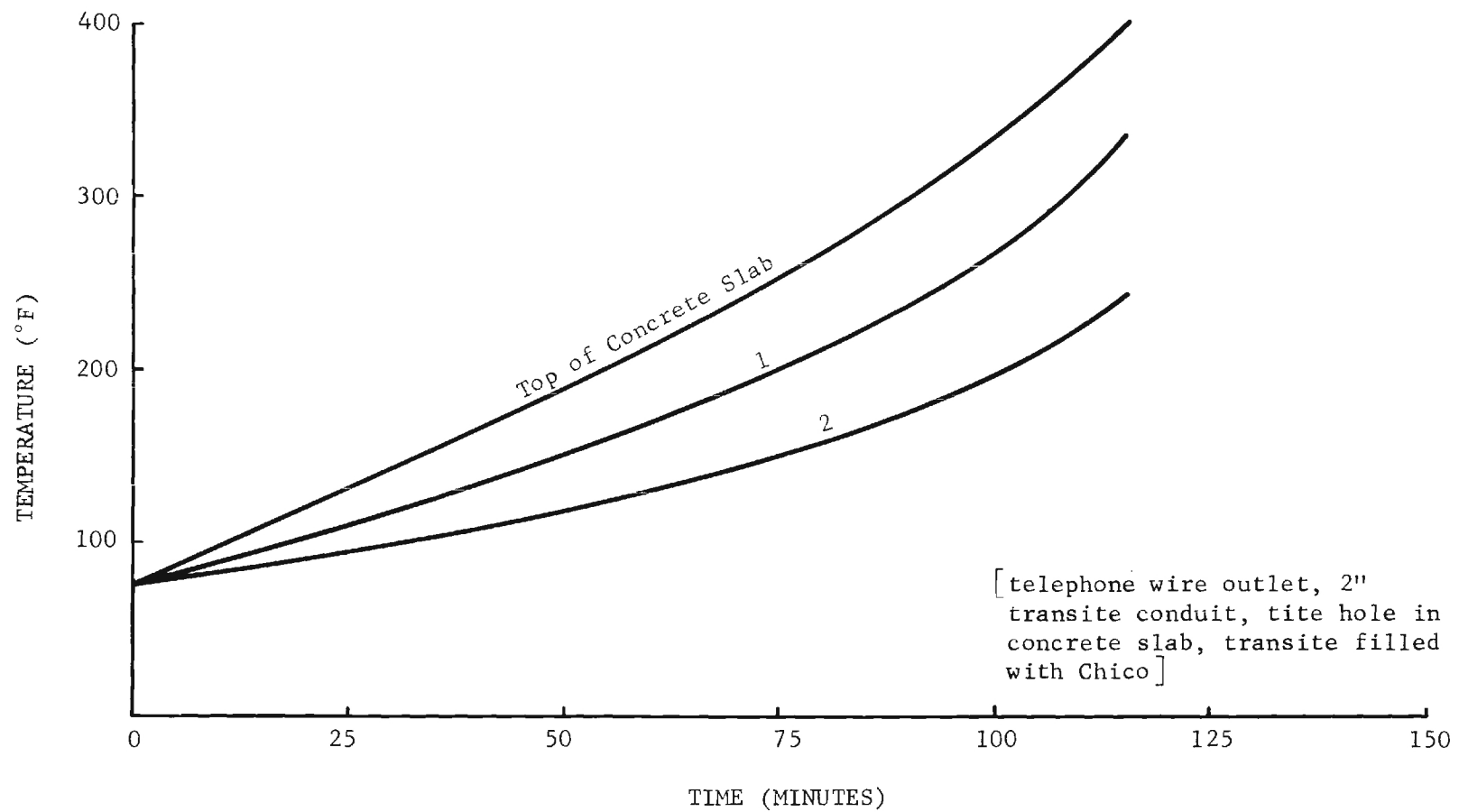


Figure 16. Temperature versus Time for Fire Test of Poke-Thru System Number 8 with Temperature Measurement at Bottom (Number 1) and Top (Number 2) of Poke-Thru Cover.

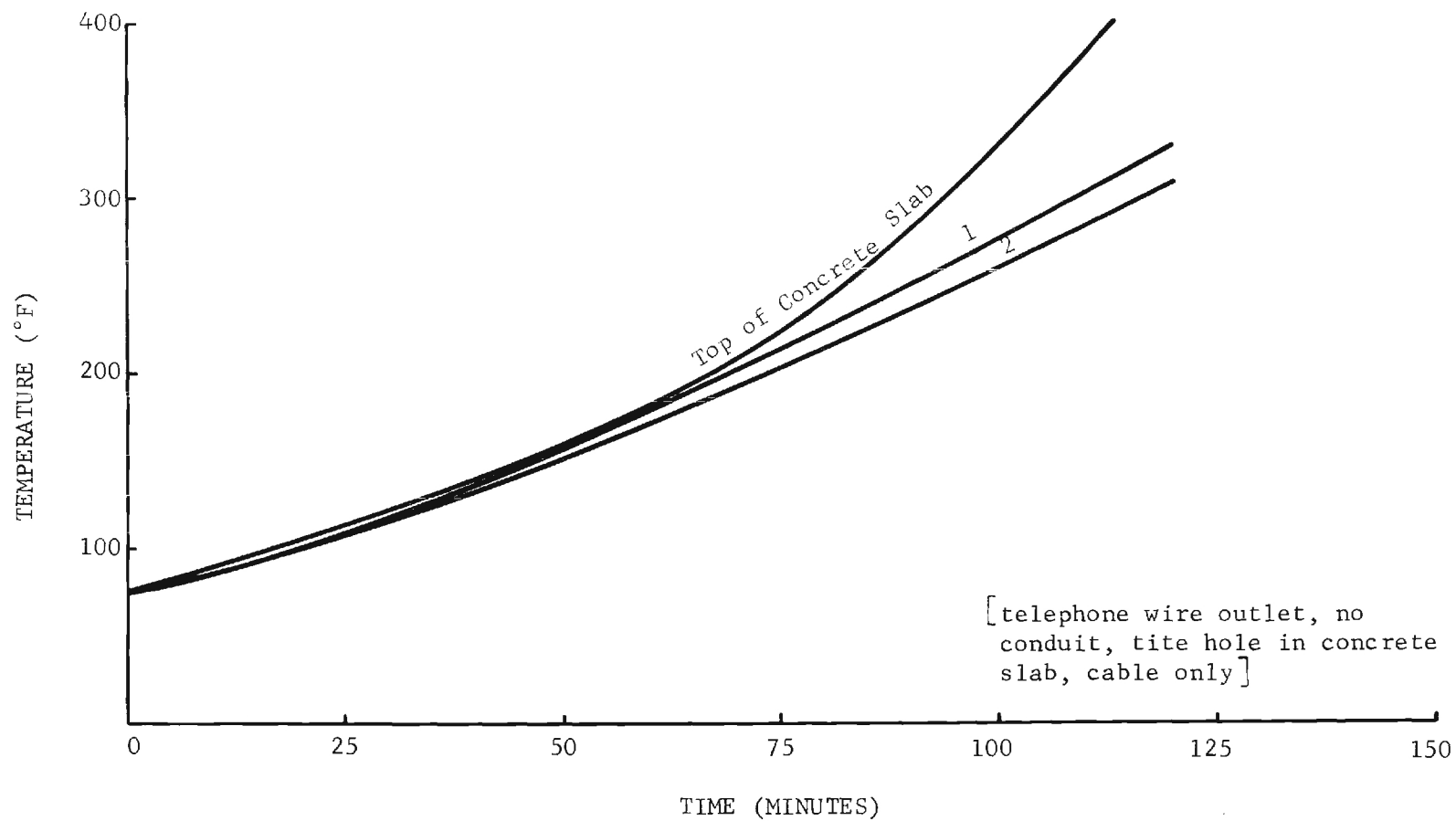


Figure 17. Temperature versus Time for Fire Test of Poke-Thru System Number 9 with Temperature Measurement at Bottom (Number 1) and Top (Number 2) of Poke-Thru Cover.

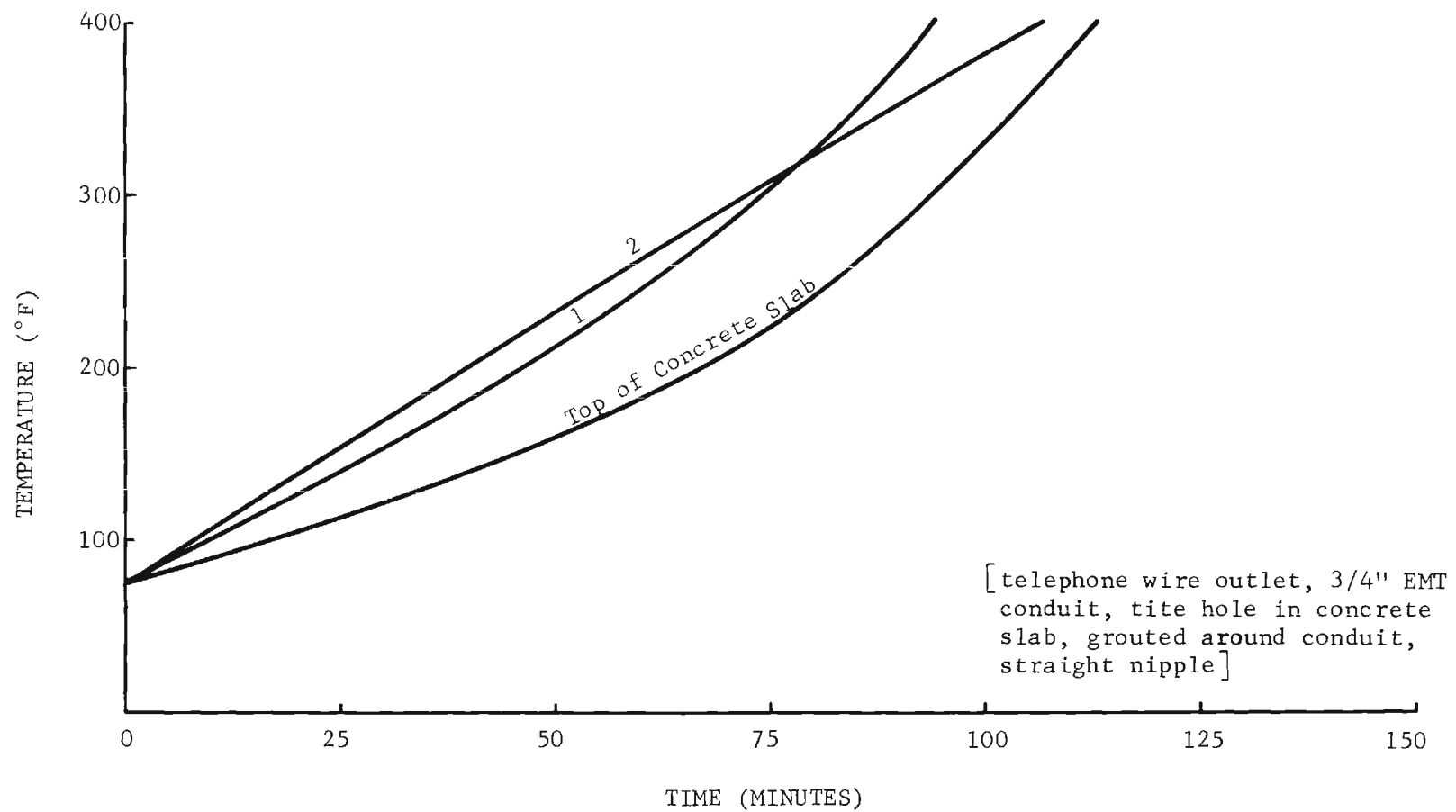


Figure 18. Temperature versus Time for Fire Test of Poke-Thru System Number 10 with Temperature Measurement at Bottom (Number 1) and Top (Number 2) of Poke-Thru Cover.

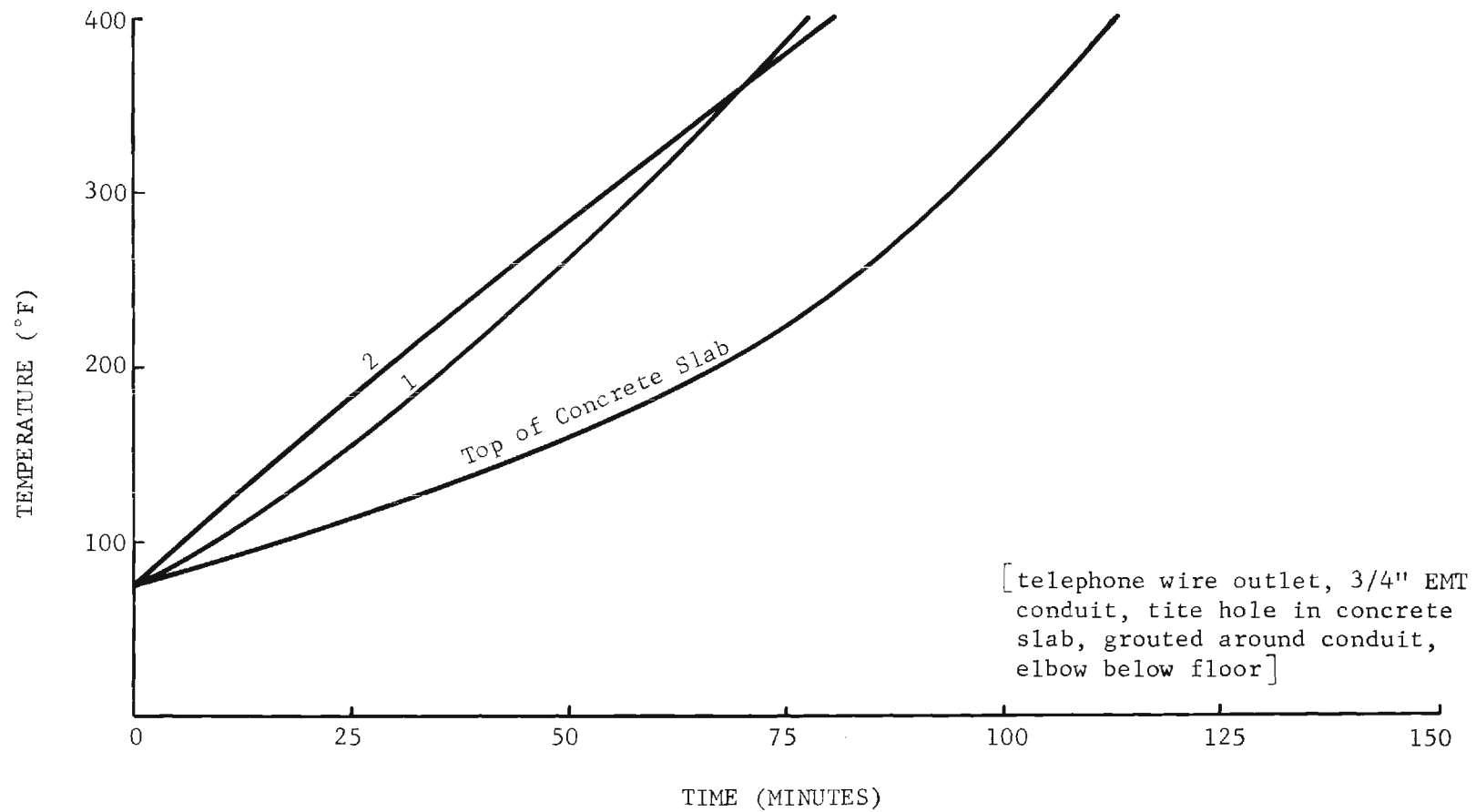


Figure 19. Temperature versus Time for Fire Test of Poke-Thru System Number 11 with Temperature Measurement at Bottom (Number 1) and Top (Number 2) of Poke-Thru Cover.

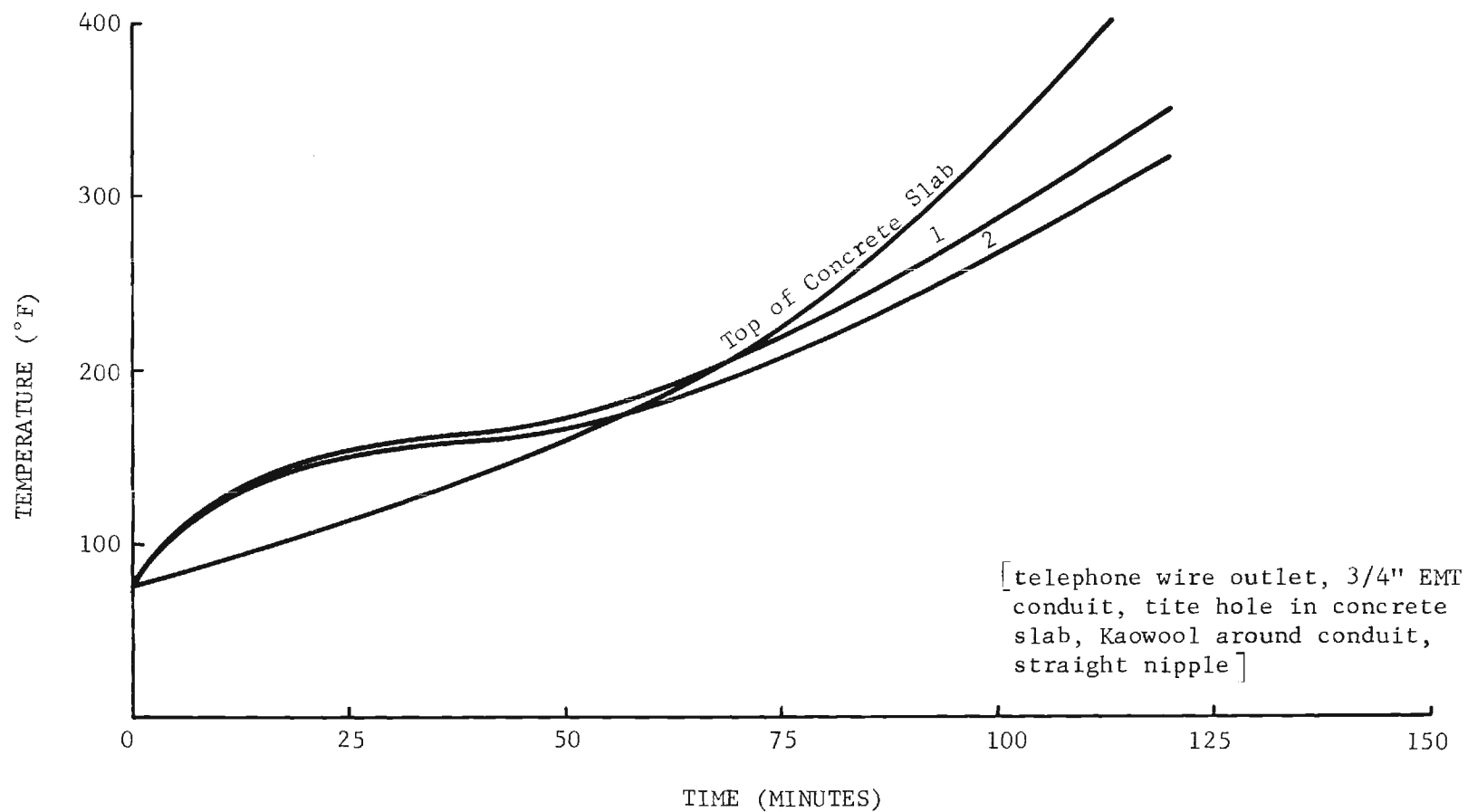


Figure 20. Temperature versus Time for Fire Test of Poke-Thru System Number 12 with Temperature Measurement at Bottom (Number 1) and Top (Number 2) of Poke-Thru Cover.

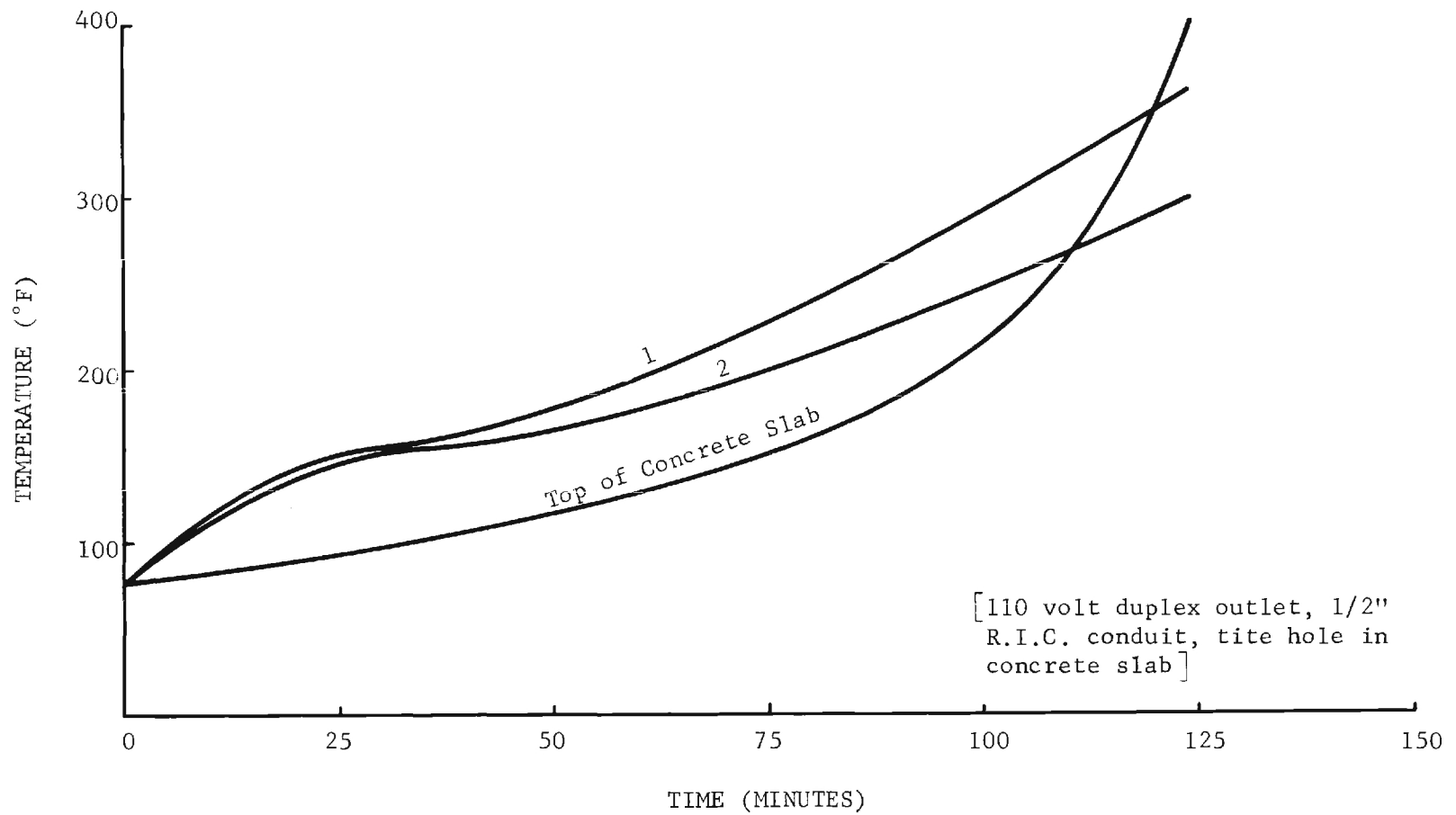


Figure 21. Temperature versus Time for Fire Test of Poke-Thru System Number 13 with Temperature Measurement at Bottom (Number 1) and Top (Number 2) of Poke-Thru Cover.

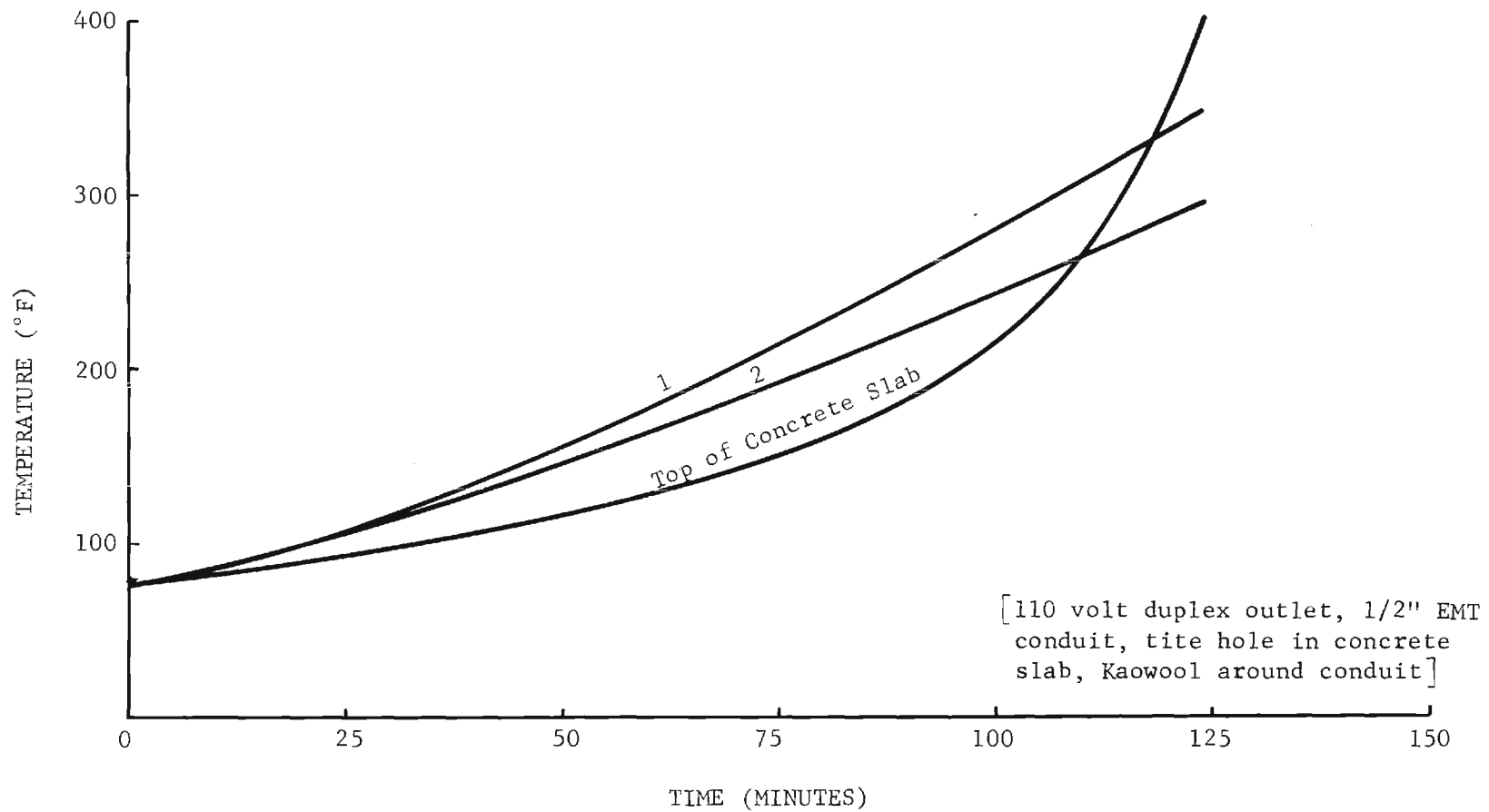


Figure 22. Temperature versus Time for Fire Test of Poke-Thru System Number 14 with Temperature Measurement at Bottom (Number 1) and Top (Number 2) of Poke-Thru Cover.

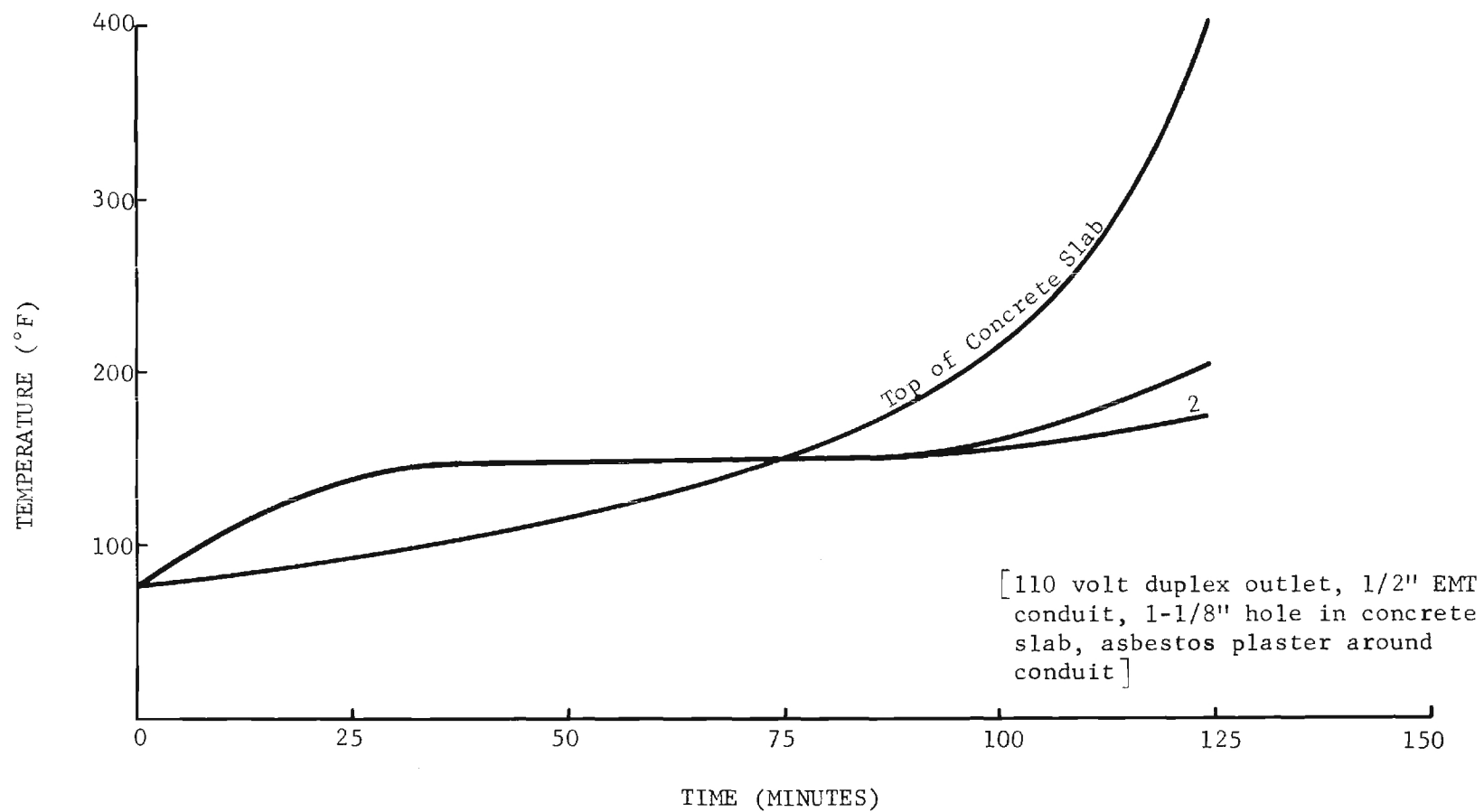


Figure 23. Temperature versus Time for Fire Test of Poke-Thru System Number 15 with Temperature Measurement at Bottom (Number 1) and Top (Number 2) of Poke-Thru Cover.

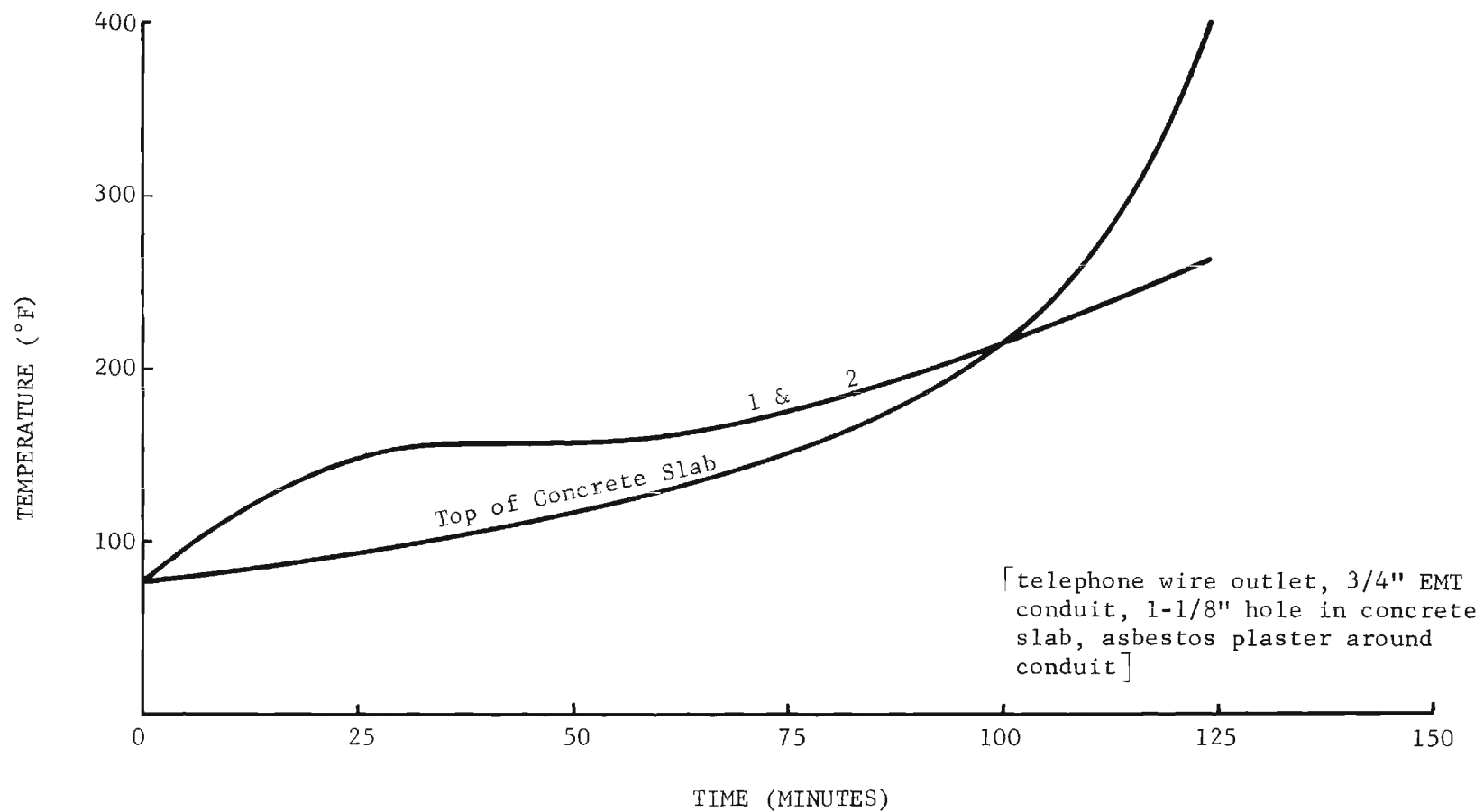


Figure 24. Temperature versus Time for Fire Test of Poke-Thru System Number 16 with Temperature Measurement at Bottom (Number 1) and Top (Number 2) of Poke-Thru Cover.

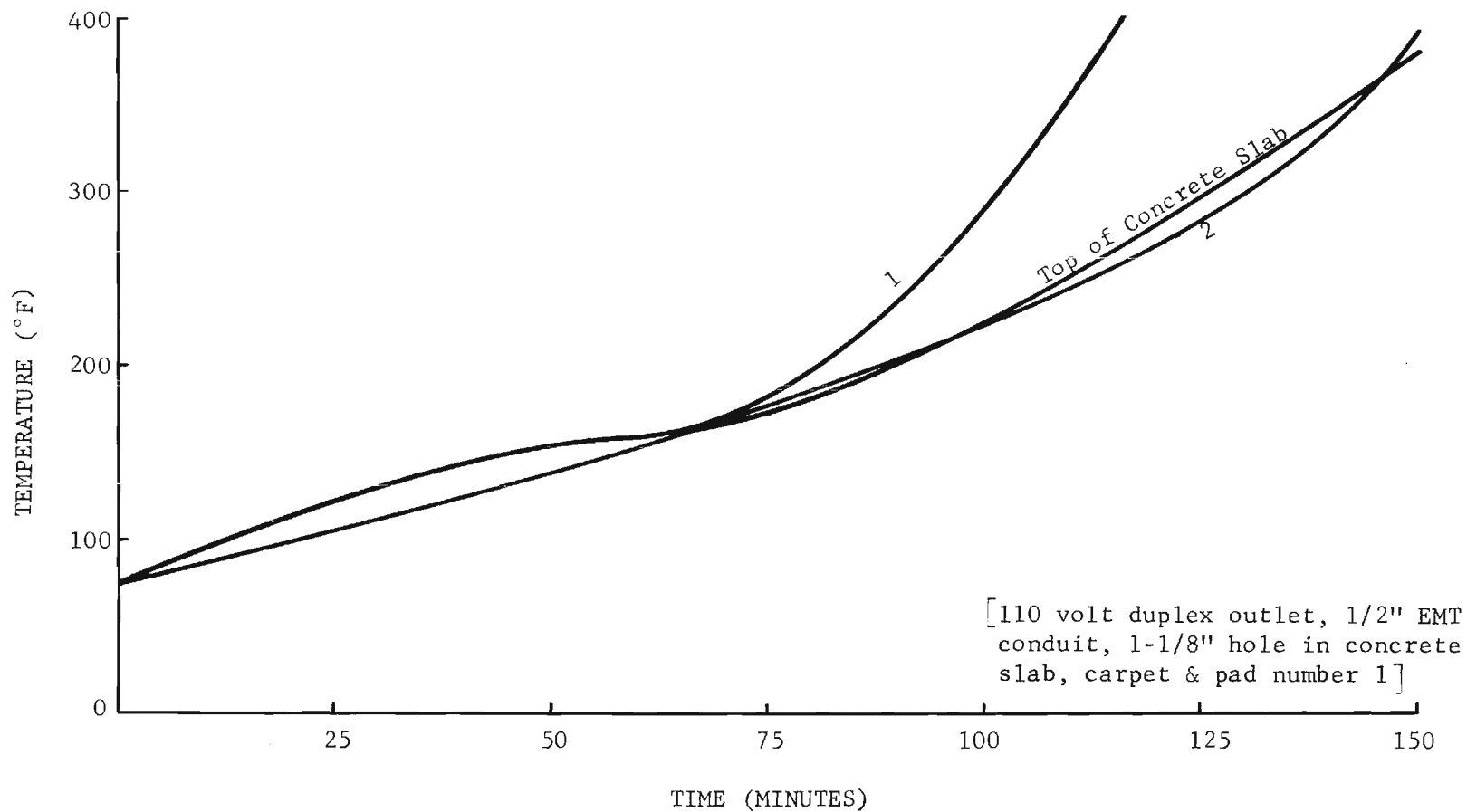


Figure 25. Temperature versus Time for Fire Test of Poke-Thru System Number 17 with Temperature Measurement at Bottom (Number 1) and Top (Number 2) of Poke-Thru Cover.

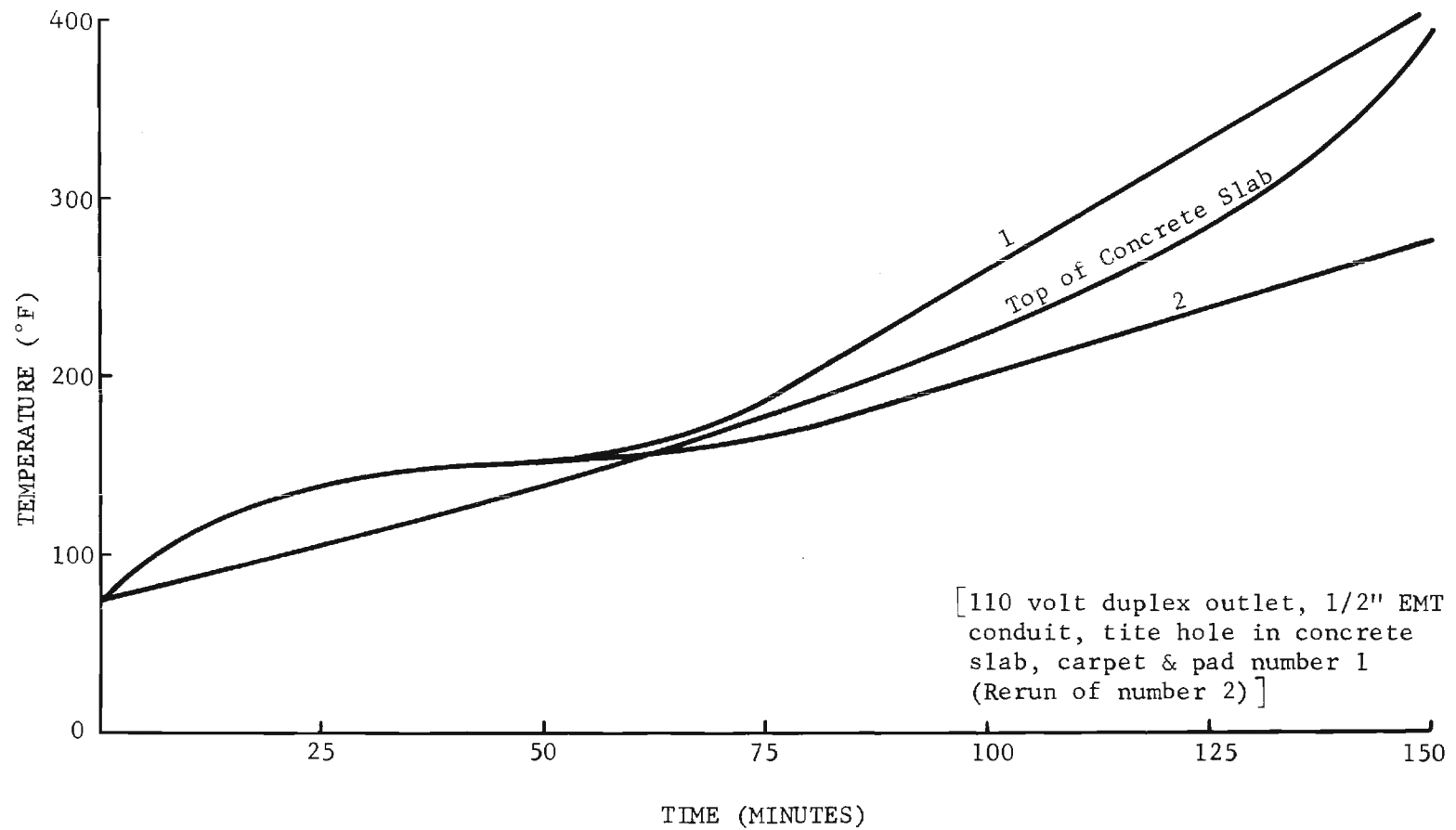


Figure 26. Temperature versus Time for Fire Test of Poke-Thru System Number 18 with Temperature Measurement at Bottom (Number 1) and Top (Number 2) of Poke-Thru Cover.

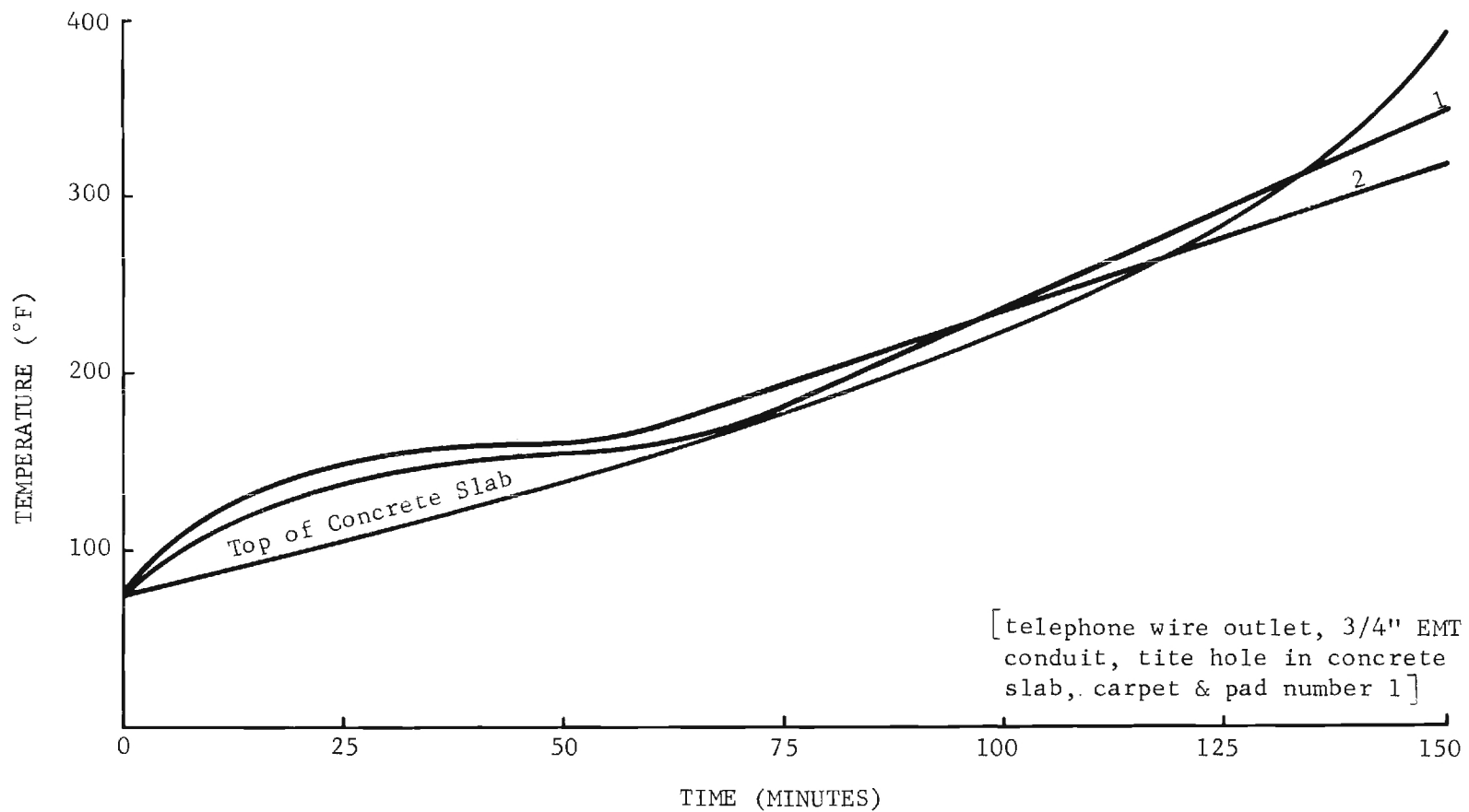


Figure 27. Temperature versus Time for Fire Test of Poke-Thru System Number 19 with Temperature Measurement at Bottom (Number 1) and Top (Number 2) of Poke-Thru Cover.

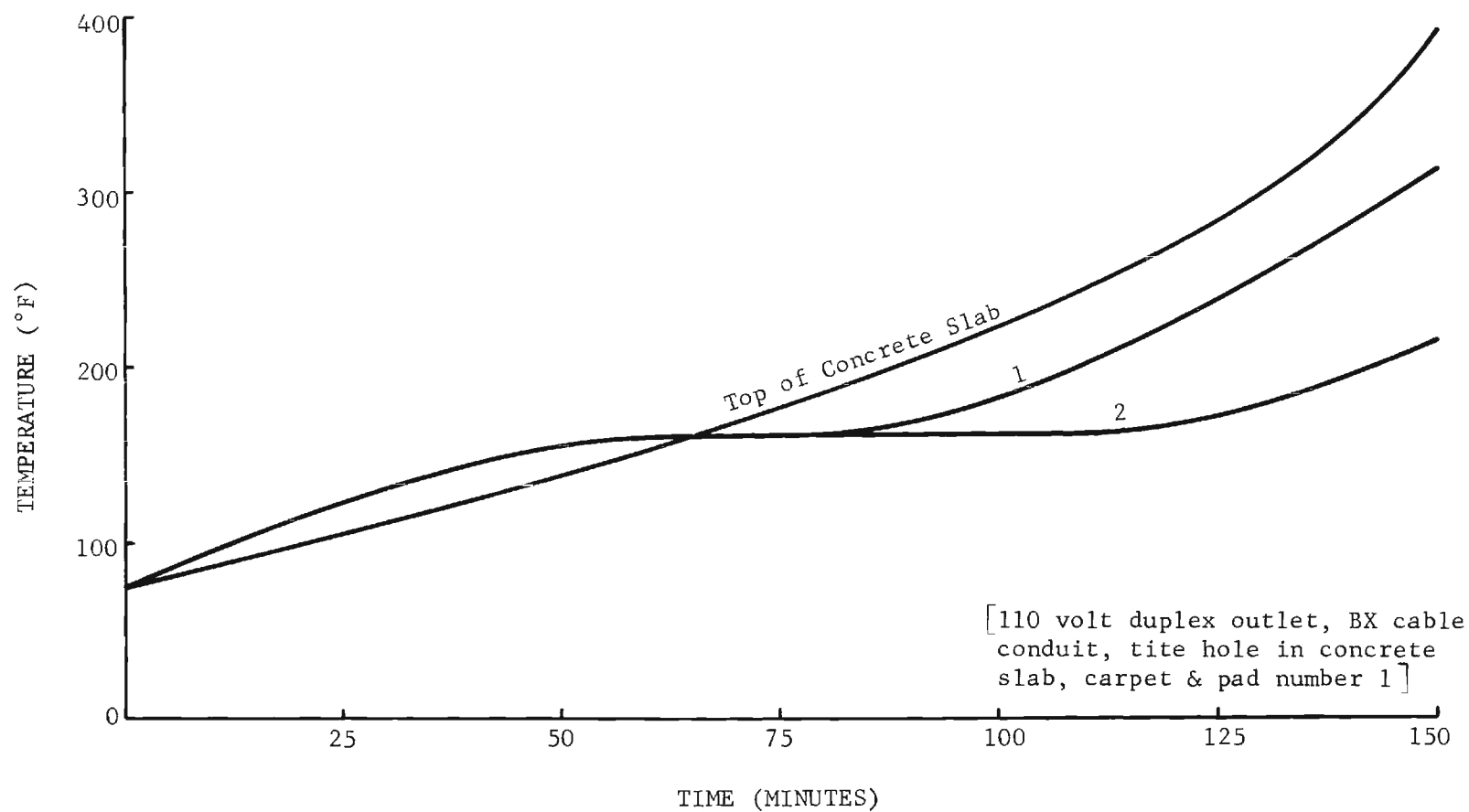


Figure 28. Temperature versus Time for Fire Test of Poke-Thru System Number 20 with Temperature Measurement at Bottom (Number 1) and Top (Number 2) of Poke-Thru Cover.

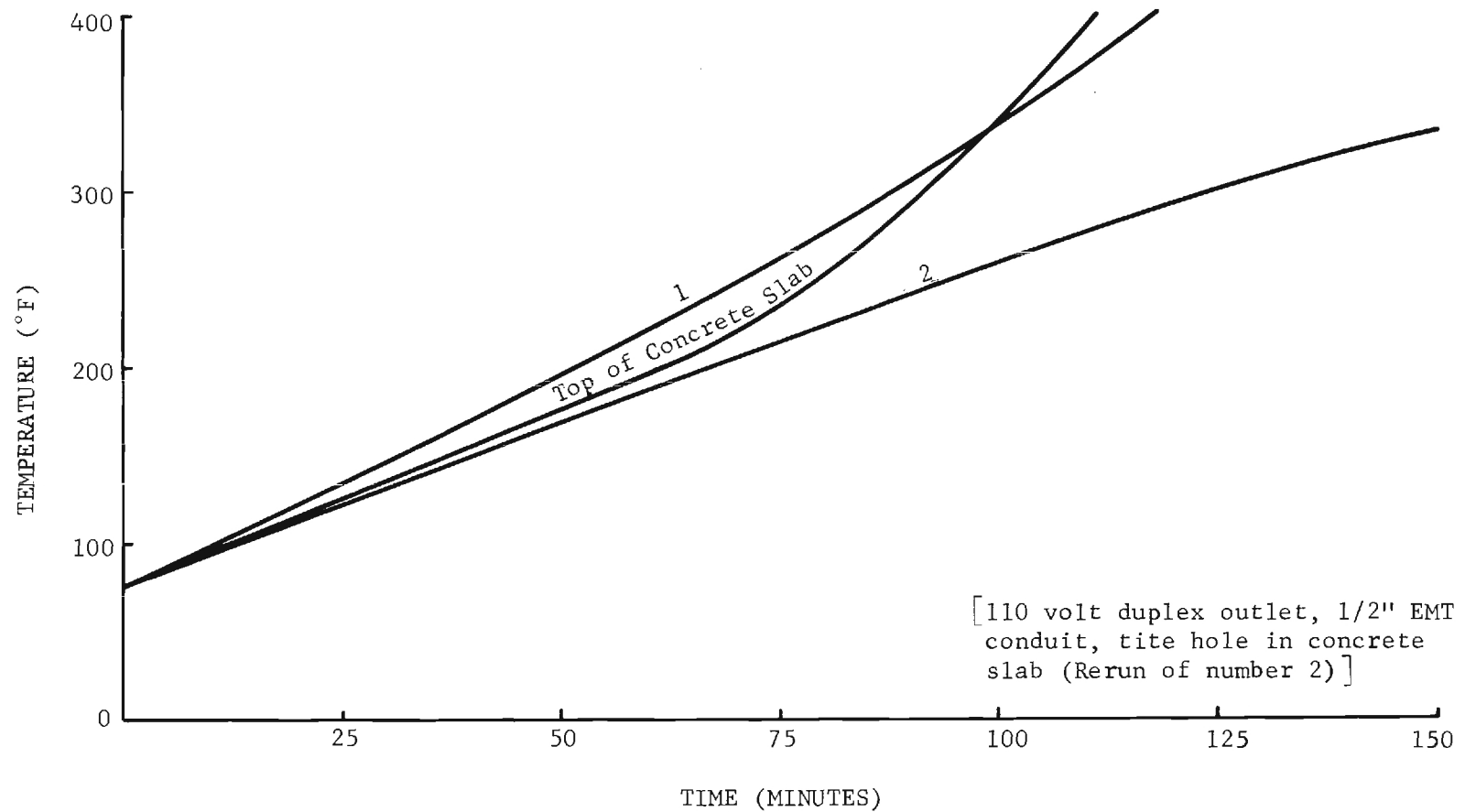


Figure 29. Temperature versus Time for Fire Test of Poke-Thru System Number 21 with Temperature Measurement at Bottom (Number 1) and Top (Number 2) of Poke-Thru Cover.

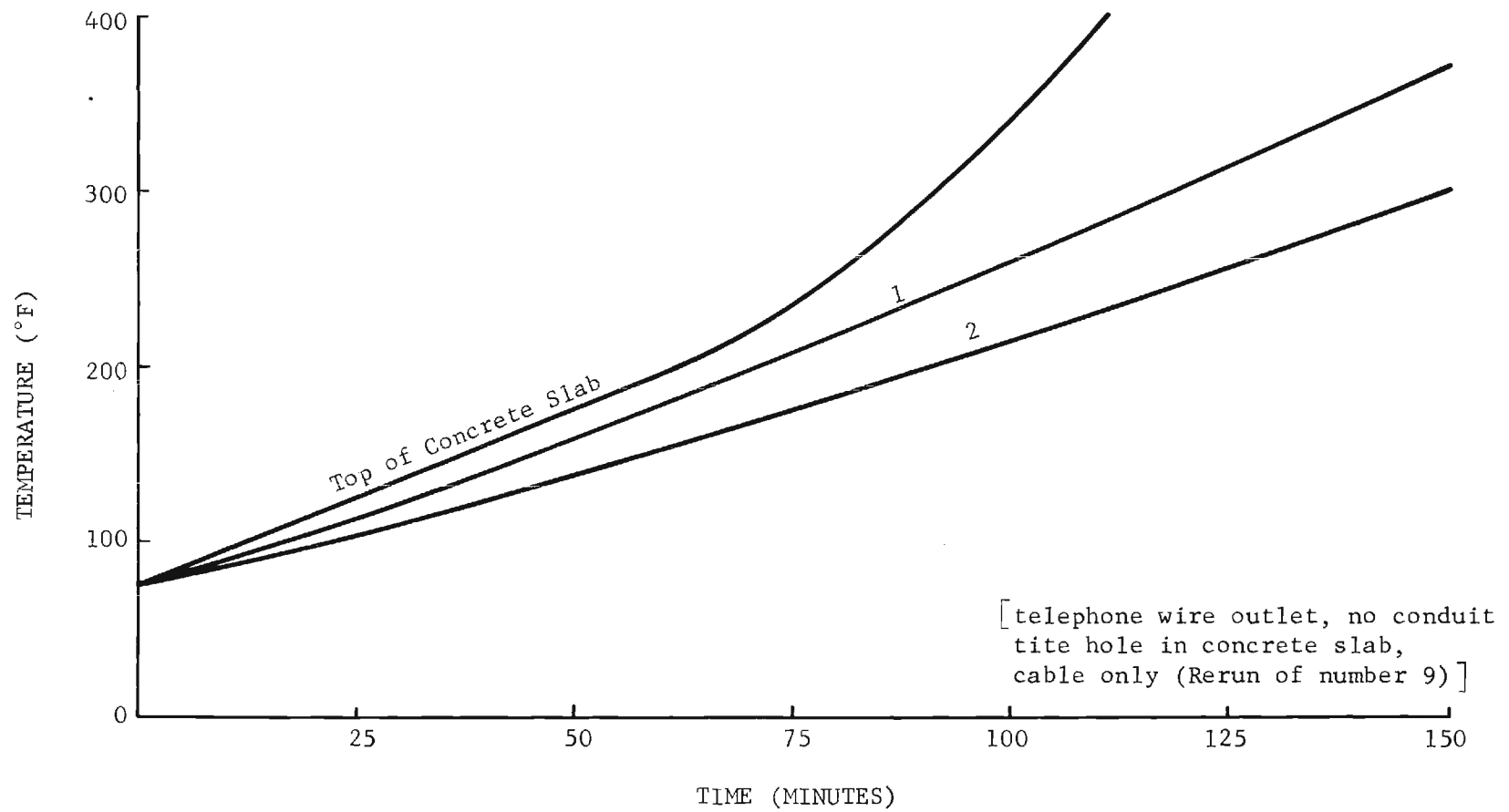


Figure 30. Temperature versus Time for Fire Test of Poke-Thru System Number 22 with Temperature Measurement at Bottom (Number 1) and Top (Number 2) of Poke-Thru Cover.

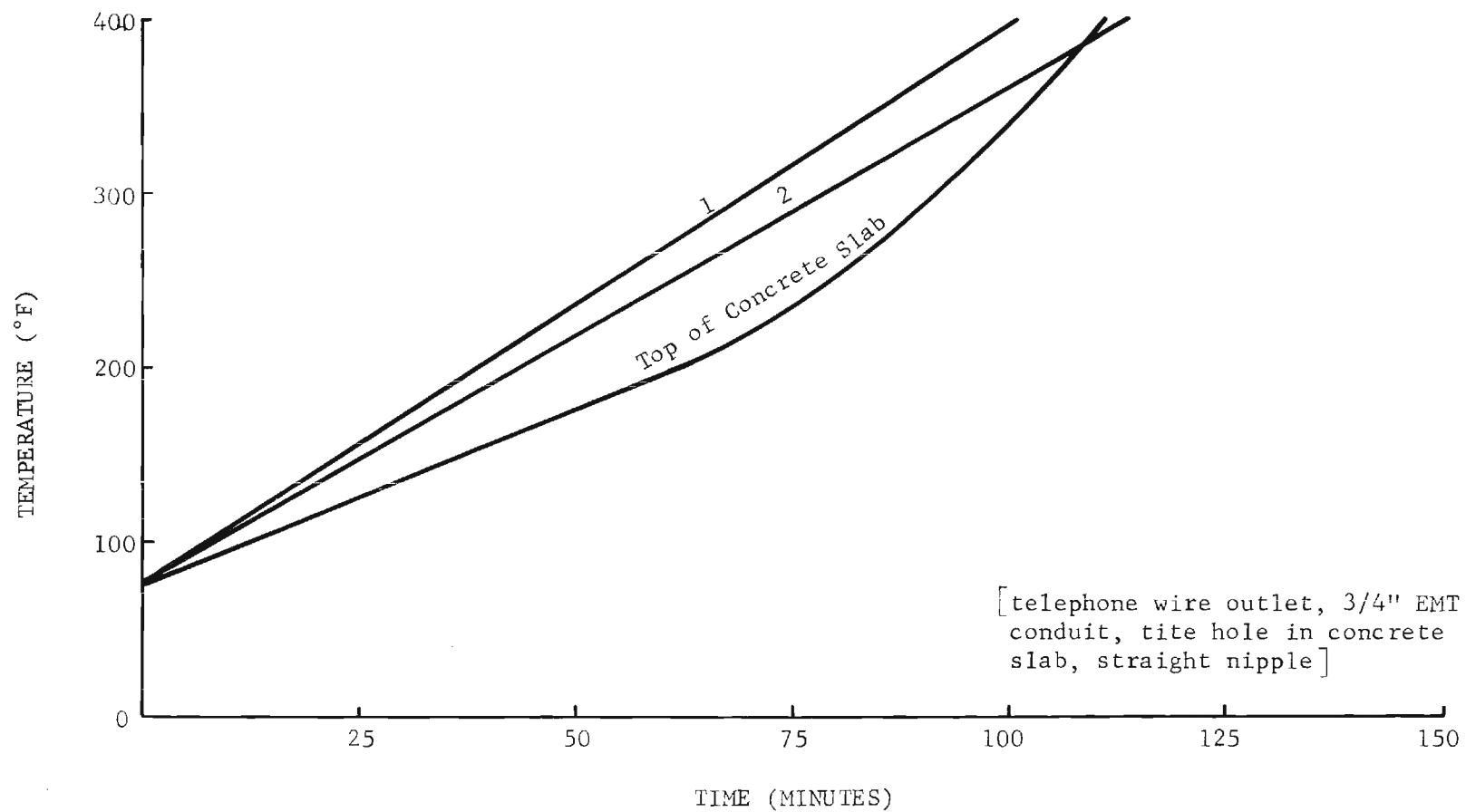


Figure 31. Temperature versus Time for Fire Test of Poke-Thru System Number 23 with Temperature Measurement at Bottom (Number 1) and Top (Number 2) of Poke-Thru Cover.

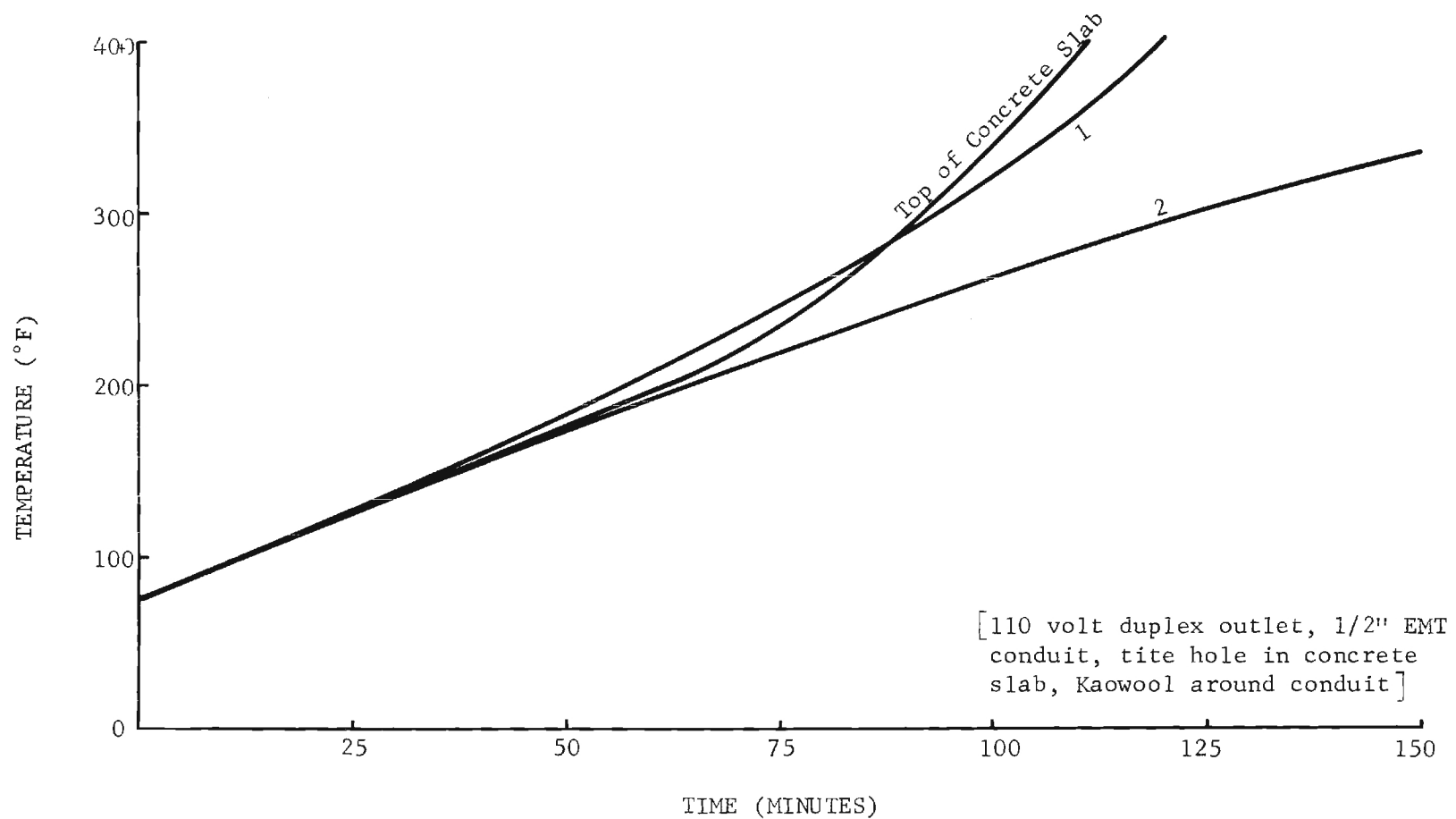


Figure 32. Temperature versus Time for Fire Test of Poke-Thru System Number 24 with Temperature Measurement at Bottom (Number 1) and Top (Number 2) of Poke-Thru Cover.

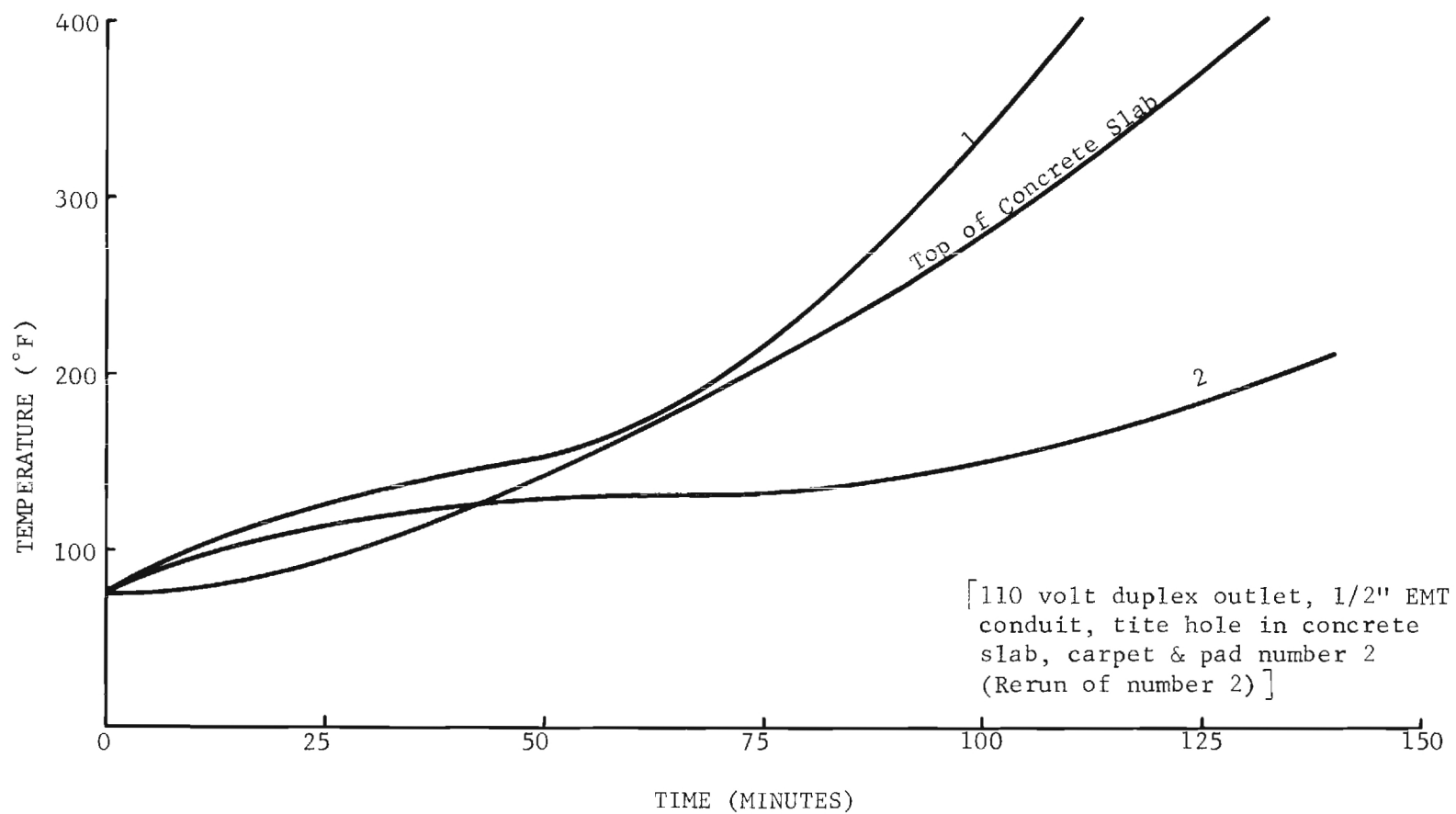


Figure 33. Temperature versus Time for Fire Test of Poke-Thru System Number 25 with Temperature Measurement at Top of Poke-Thru Cover (Number 1) and Under Carpet (Number 2).

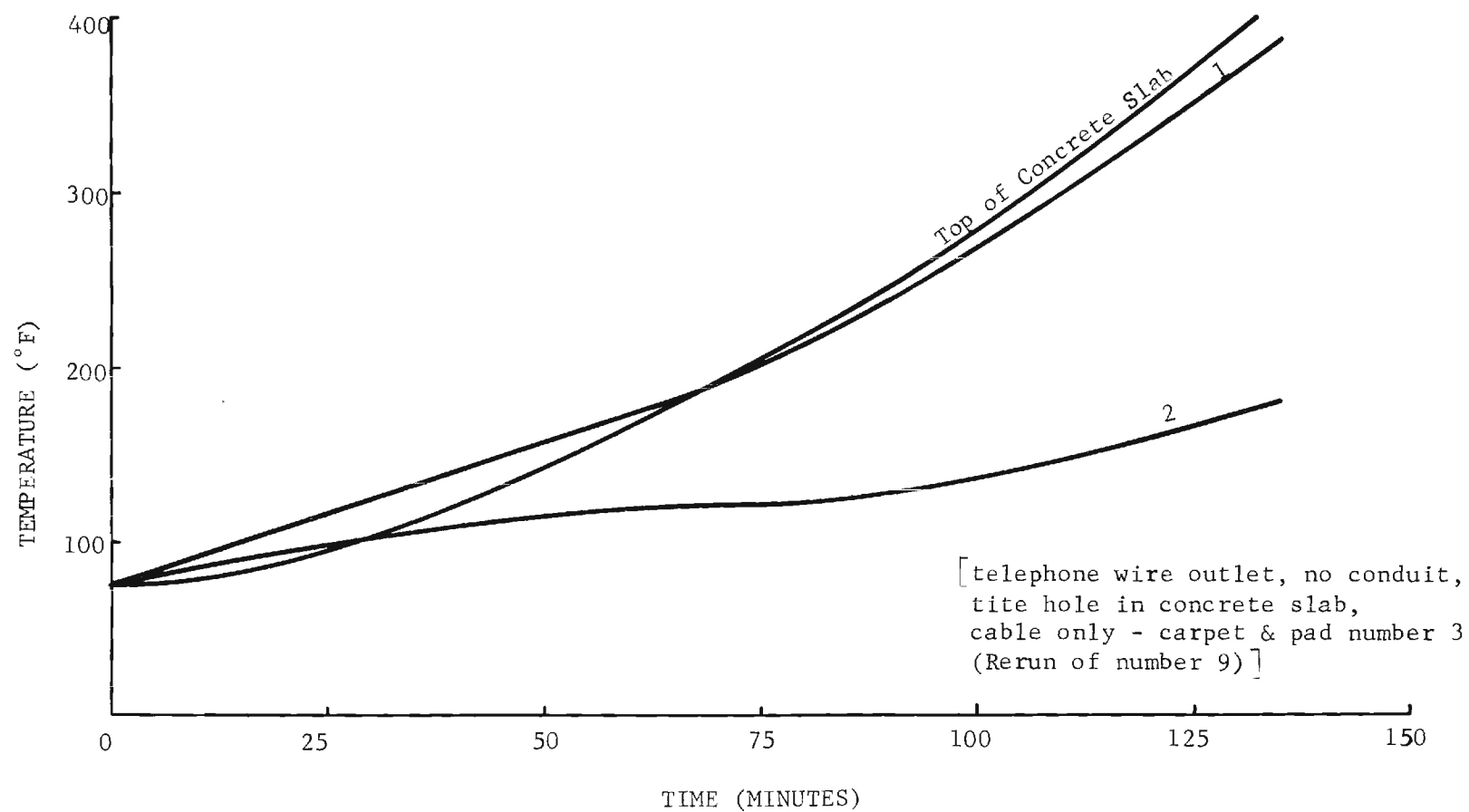


Figure 34. Temperature versus Time for Fire Test of Poke-Thru System Number 26 with Temperature Measurement at Top of Poke-Thru Cover (Number 1) and Under Carpet (Number 2).

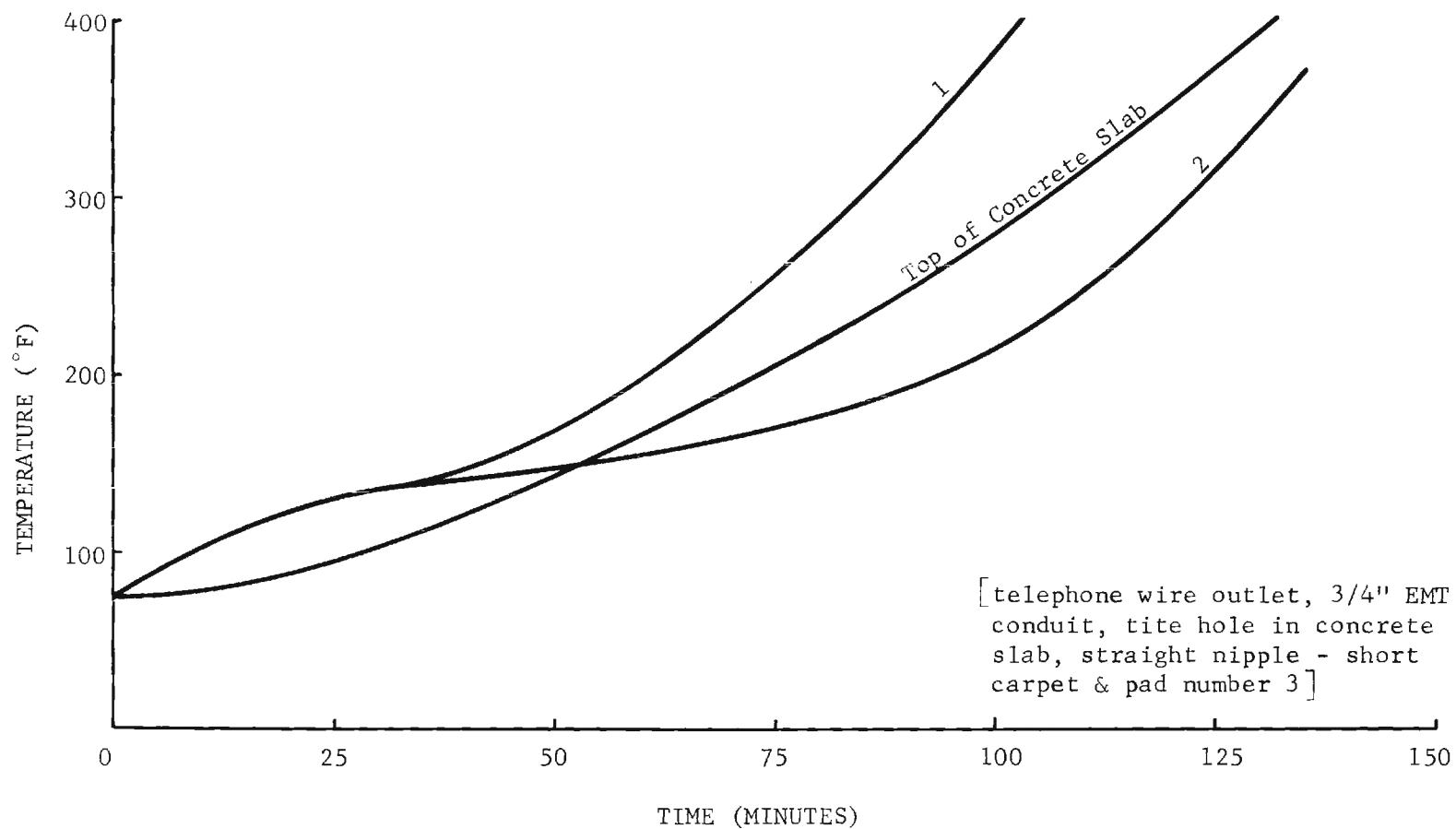


Figure 35. Temperature versus Time for Fire Test of Poke-Thru System Number 27 with Temperature Measurement at Top of Poke-Thru Cover (Number 1) and Under Carpet (Number 2).

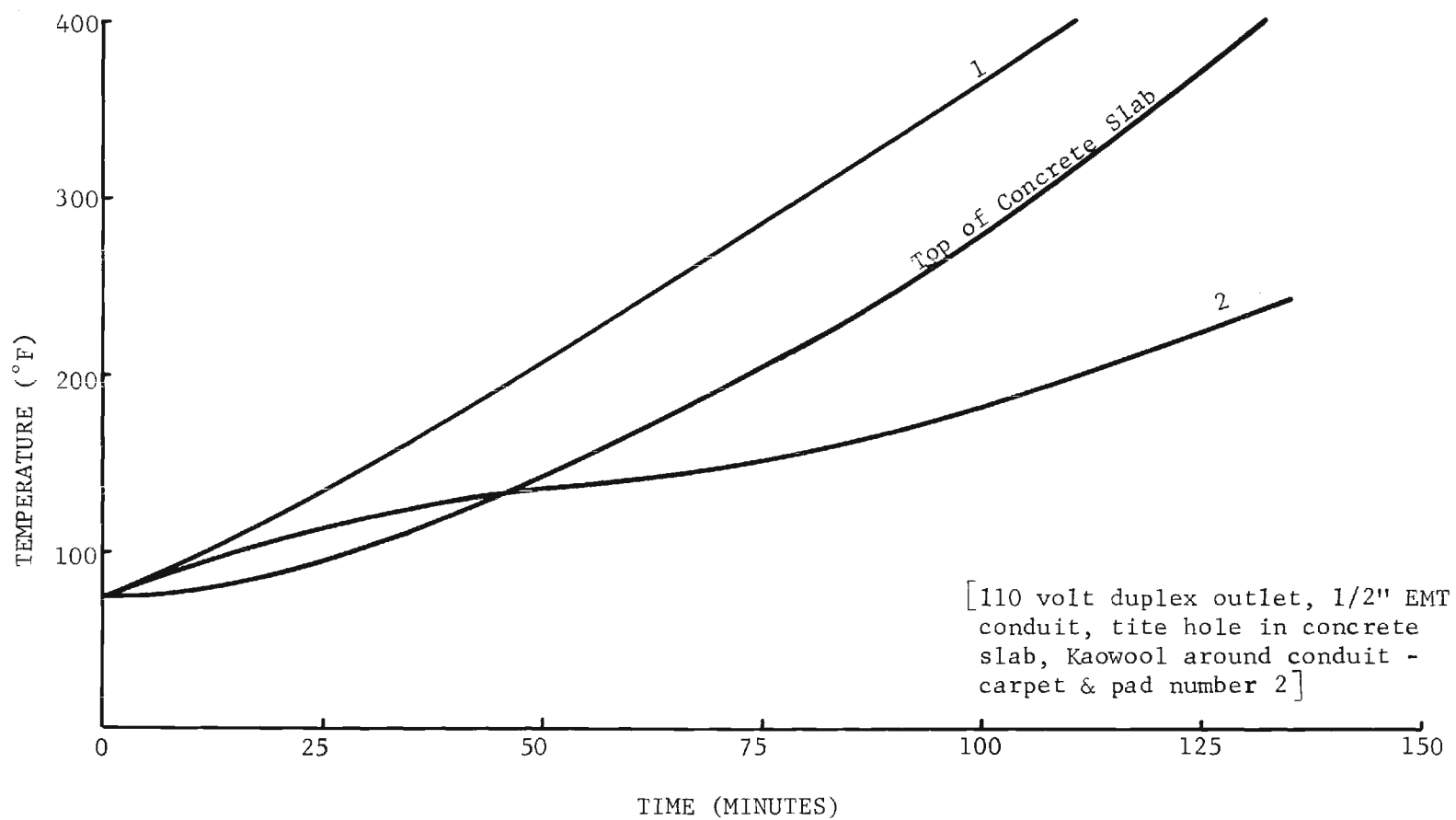


Figure 36. Temperature versus Time for Fire Test of Poke-Thru System Number 28 with Temperature Measurement at Top of Poke-Thru Cover (Number 1) and Under Carpet (Number 2).

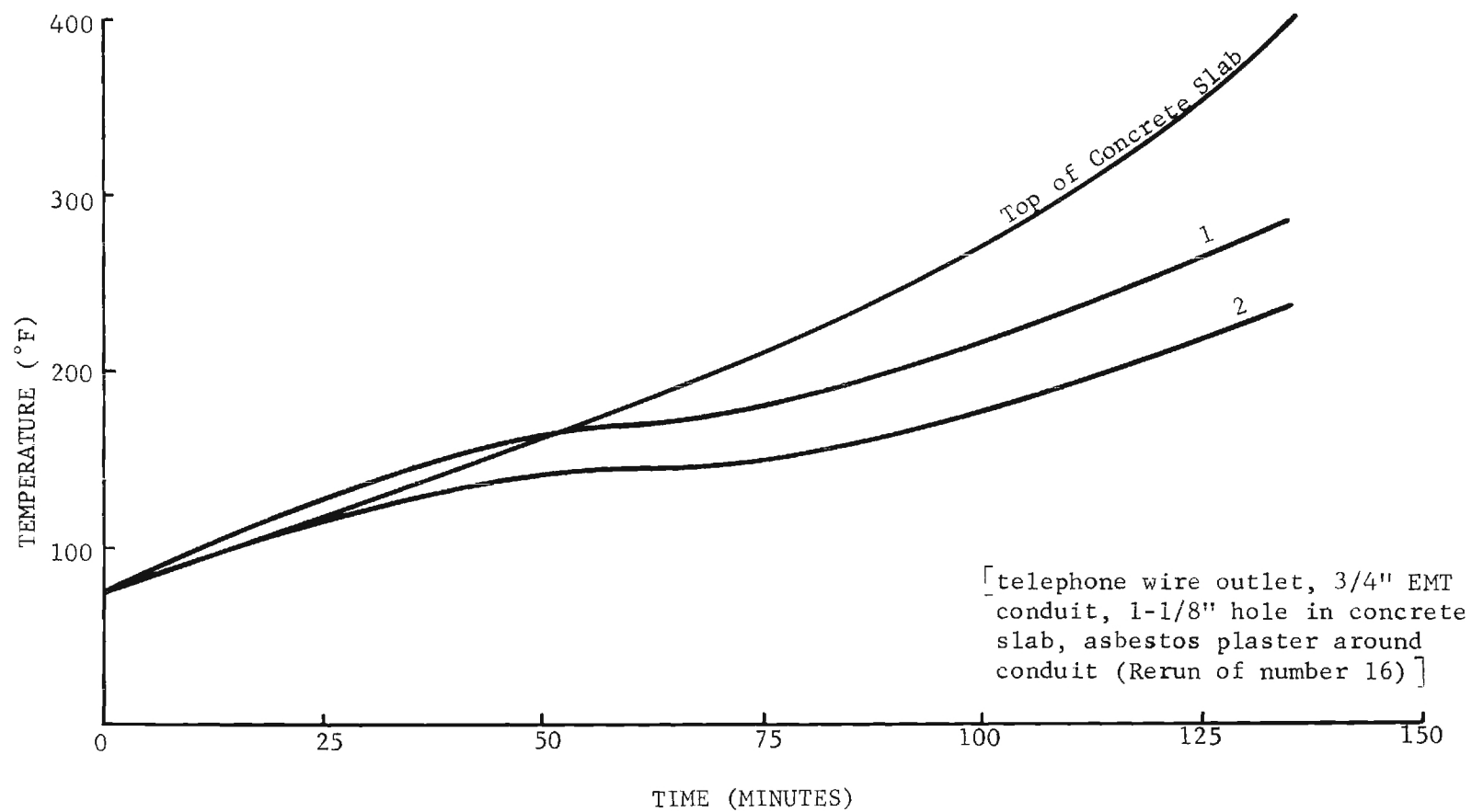


Figure 37. Temperature versus Time for Fire Test of Poke-Thru System Number 29 with Temperature Measurement at Bottom (Number 1) and Top (Number 2) of Poke-Thru Cover.

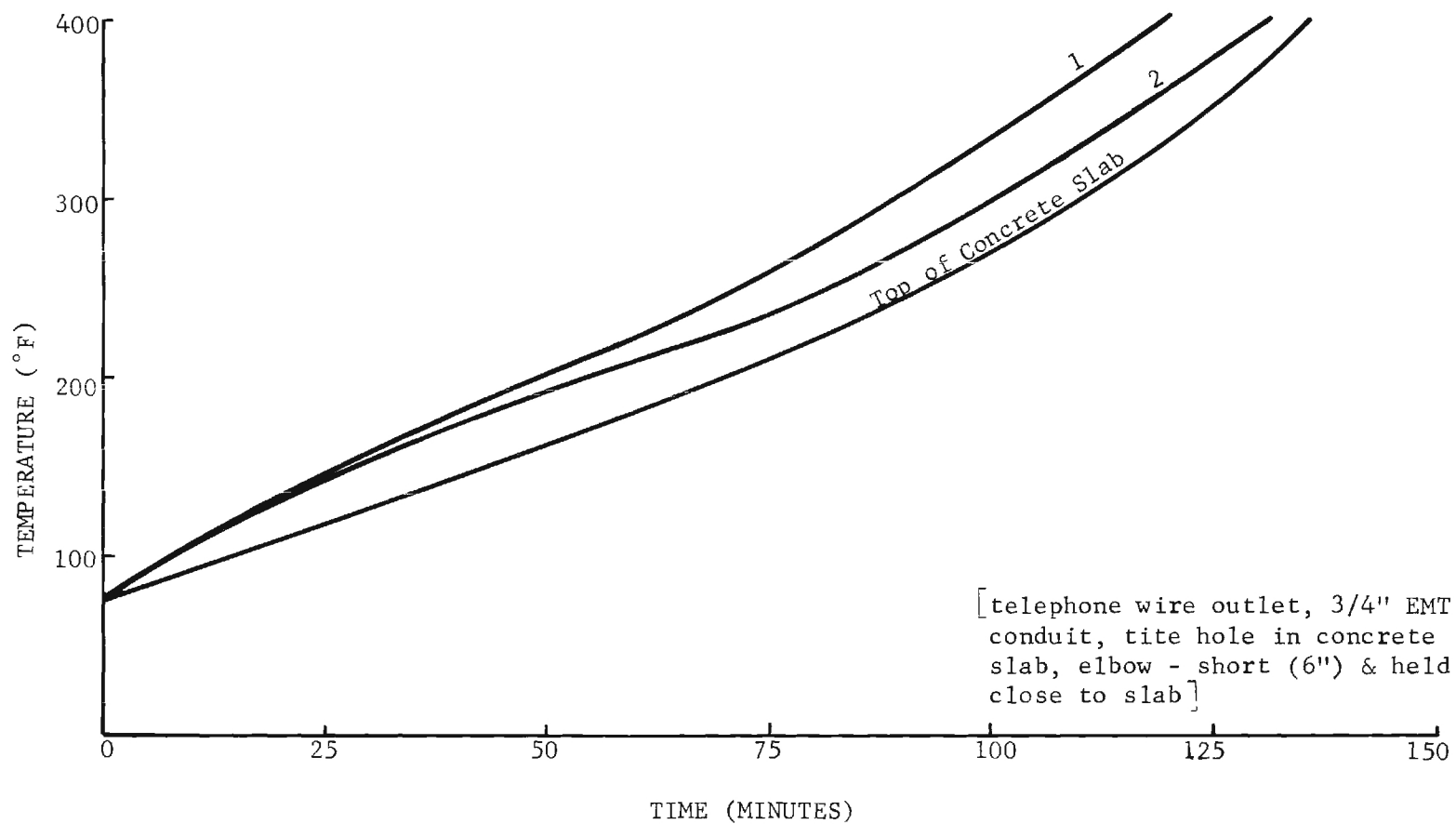


Figure 38. Temperature versus Time for Fire Test of Poke-Thru System Number 30 with Temperature Measurement at Bottom (Number 1) and Top (Number 2) of Poke-Thru Cover.

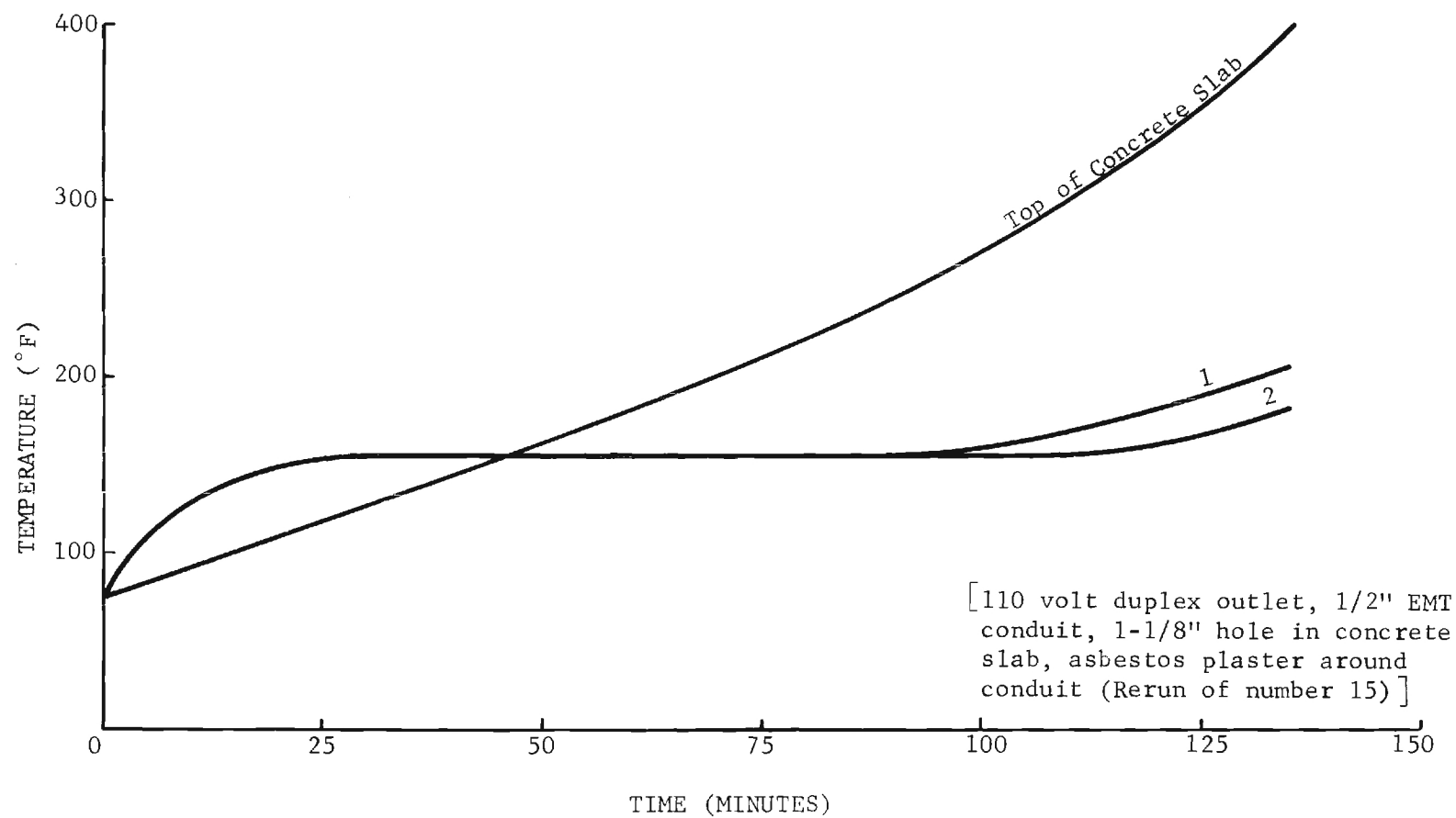


Figure 39. Temperature versus Time for Fire Test of Poke-Thru System Number 31 with Temperature Measurement at Bottom (Number 1) and Top (Number 2) of Poke-Thru Cover.

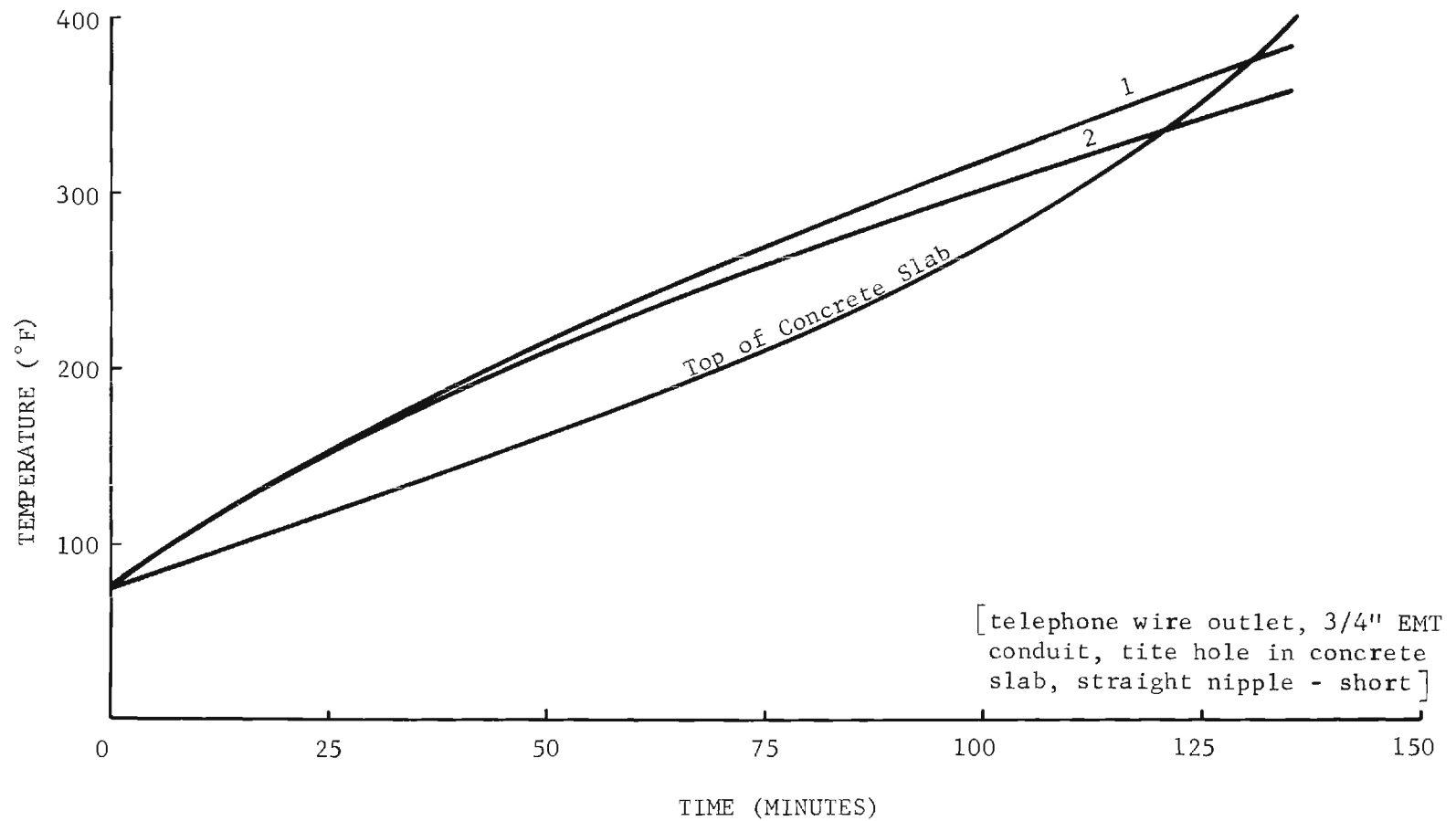


Figure 40. Temperature versus Time for Fire Test of Poke-Thru System Number 32 with Temperature Measurement at Bottom (Number 1) and Top (Number 2) of Poke-Thru Cover.

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